MACHINERY.

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MONEY AND MONEY-MAKING MACHINERY.

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IT has been said that one of the most important functions of the government is the creation of money and its distribution. Money itself is the most important instrument of civilization in contributing to human comfort and enjoyment. With pieces of paper bearing the seal of the Treasury of the United States, the holder can procure for his use any article of necessity or luxury produced in the world. Without this contrivance called money, he would be compelled to live within very narrow limitations, and his conveniences and comforts would be but little better than those of a savage. It is not the province of this paper to discuss the money question, nor to volunteer individual opinions as to the prospective future policy of the United States with reference to its money, but it is proper to say that the tendency of modern thought and civilization is to regard the issue of all kinds of money as distinctly a national function, to be exercised only by that sovereign power whose mandates and prerogatives constitute the supreme law of the land. Therefore, a word or two in these times of financial stringency, concerning the machinery and the manner of producing our national currency, may prove of interest.

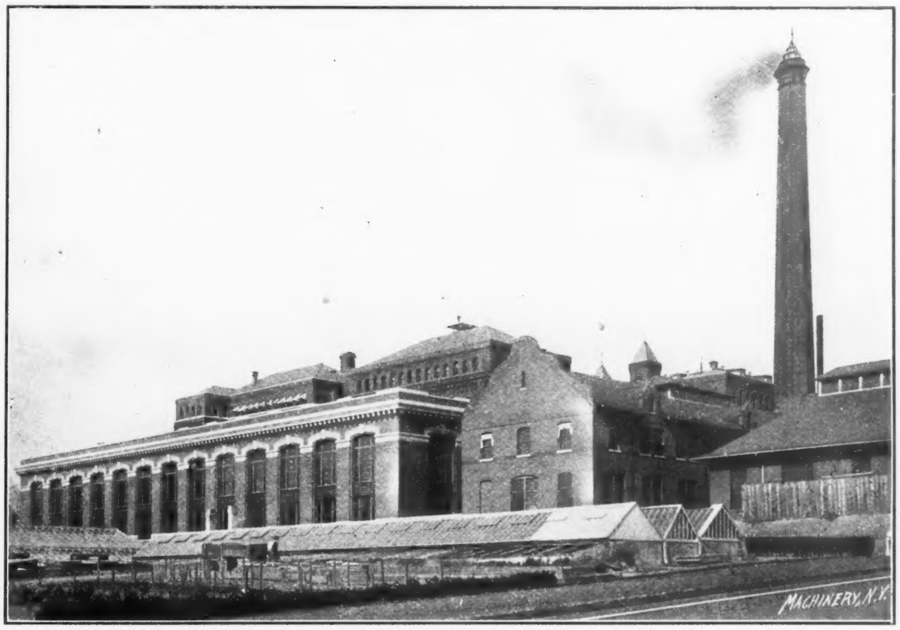

Fig. 1. Bureau of Engraving and Printing, where the Paper Money is made—and afterwards destroyed.

In a general way, most every one knows that our so-called paper money is made at the Bureau of Engraving and Printing, at Washington, but it is safe to say that very few outside of those directly connected with the industry, know that practically all of the important machines used in bank-note engraving, not only in the United States, but all over the civilized world, are supplied by less than half a dozen concerns in Newark, N. J.

The office of the Bureau of Engraving and Printing is to design, engrave, and print all the obligations of the government of the United States, including the interest-bearing bonds, the treasury notes, the national bank-notes, and the gold and silver certificates; also to design, engrave and print the customs and internal revenue stamps, postage stamps, and checks and drafts used in the different departments of the government.

Until recent years, the postage stamps were printed by private bank-note companies, who were the lowest bidders in competition with the Bureau of Engraving and Printing. The Secretary of the Treasury selects the subjects which appear on the face of the government money and securities. The portraits only of departed citizens who have won distinction are used. Living subjects are not reproduced in the design. The designs are made under the supervision of the Chief of the Engravers' Division of the Bureau, and all are subject to the approval of the Secretary of the Treasury.

The designs on the government money are engraved on steel dies. The complete design for the engraving having been selected, a corps of engravers begins work on the different parts of the design. One engraver may work upon the portrait, one upon the lettering, and others upon the ornate work. The engraving of an entire design is never entrusted to a single person, and the whole design is never made upon a single plate, but in sections. When the engraving on the different sections is completed, the dies are hardened and tempered. Sectional rolls, of soft steel, are then passed over the hardened dies by pressure, and the design is transferred in relief to the roll. Each sectional roll bears a part of the complete design. The whole design is then transferred to one piece of steel called the bed-piece, from which a complete roll is made. The finished roll is then tempered and hardened, and four notes are transferred to each plate. This plate is also hardened, and is then ready for the printer. When the complete roll and the printing plates are worn out, recurrence is had to the original rolls, and when these rolls are unfit for further use, the original dies are brought into requisition for the production of new rolls and plates. Rolls and plates are hardened by the cyanide of potash process.

The paper money of the United States, when it is new and fresh from the press, is the finest in the world, and its production is the most expensive. The paper used is made by the Crane Mills, at Dalton, Mass., expressly for the Bureau of Engraving and Printing, and directly under its supervision. It is composed of fine linen and silk, and a collection of silk fibers run lengthwise through the sheets. The process of its manufacture is known only to the manufacturers and the officers of the Bureau. Heavy penalties are imposed merely for the act of having the unprinted paper in possession. The commercial bank-note companies have the government's sanction to use a security paper, also made by the Crane Mills, in which planchettes or small pieces of silken fiber are interwoven in the texture of the paper during manufacture, but they are not permitted to use the kind employed by the government in the making of money.

All of the engraving on the plates used is hand work, with the exception of the fine scroll or lace work, which is done by a triumph of mechanical ingenuity known as the geometric lathe, and a cycloid ruling machine for the straight work. Most of the engraving on the back of the different denominations of paper money is the work of the geometric lathe. As these machines cost over $5,000, and as it requires an expert mathematician to operate them, it will readily be seen that the work of the counterfeiter is much embarrassed by its operation.

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Origin of the Geometric Lathe.

The first geometric lathe was invented by Charles W. Dickinson, who died in 1900, and whose business is now carried on by his son, C. W. Dickinson, Jr., at Belleville, a suburb of Newark. Mr. Dickinson, the senior, was employed as a watch-case maker, and became interested in fine machinery. "Engine turned" watch cases began to be the style, and he made his first lathe for the purpose of decorating a watch case. This was a success, and a jeweler asked him to make a machine to cut a die which could be used to decorate an oval silver salver. The salver was thirty-four inches long, and the pattern was to follow its general form in one continuous figure or set of interlaced lines. This necessitated new motions being added to the machine, the one he then had being arranged for circles only. Mr. Dickinson made the machine and it was a great success. Later a man wanted a machine to make the curved combinations on bank-notes. A thousand dollars was deposited as a guarantee, and the machine was made. Notice was sent to the individual ordering it when it was completed. Nothing was heard from him, however, and the lathe was sold to someone else. Three years afterward this man was one of a gang arrested for counterfeiting. This gave Mr. Dickinson an idea of one great use for his lathe, and the present geometric lathe, to which improvements have been added from time to time, is the result. The first one was used upon bank-note plates in 1862. Mr. Dickinson went to Washington to run the lathe he had built for the government, and stayed there a year and a half, cutting new combinations for the currency then in use, until he had succeeded in instructing someone in the intricacies of running the lathe. The geometric lathe complete is one of the finest pieces of machinery in existence. It is constructed of a number of superimposed flat plates, accurately hand scraped to surface-plates, which are actuated by cams and gearing, and these are as near perfection as it is possible for human endeavor to get them. It requires four men, about five months, to build one of these lathes, and as infinitesimal accuracy is required in laying out the work and fitting the various movements together, only the most skilled mechanics, who have had years of experience in building this class of

Fig. 2. Thomas J. Sullivan, Chief of the Bureau of Engraving and Printing.

Fig. 3. Cutting Bills Apart by Machine.

Fig. 4. A Million Dollars in Paper Money ready to be destroyed.

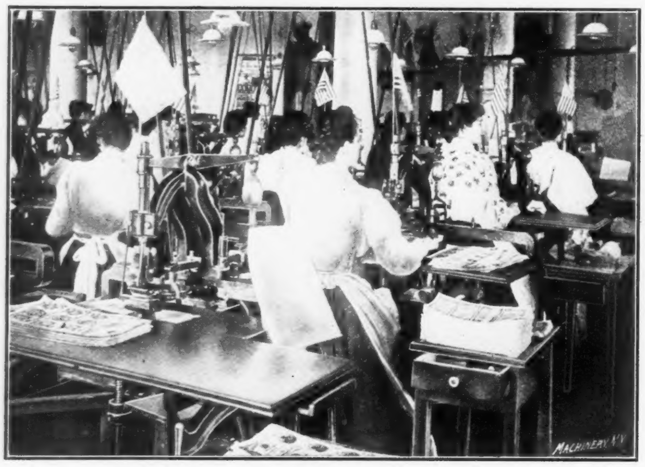

Fig. 5. Numbering Bills at the Bureau of Engraving and Printing.

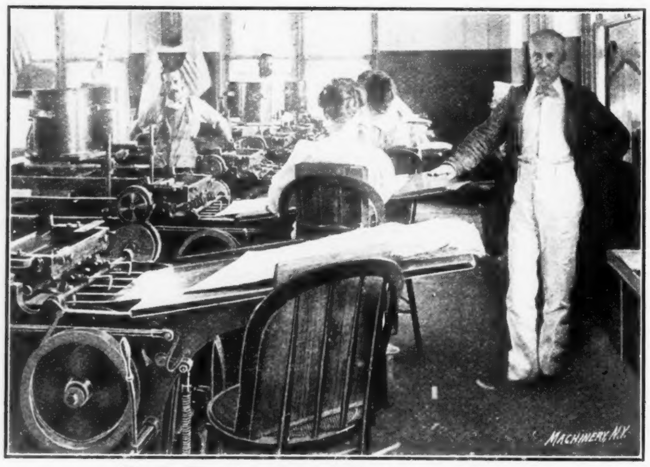

Fig. 6. Machines for Gumming Postage Stamps.

machinery, are employed in the work. The accuracy required will be appreciated when it is known that this machine will produce lines so close together that they can only be counted with the aid of a microscope. In the finer engraving, it is possible to work within a twelfth of one-thousandth of an inch. The lathe produces an almost endless combination of

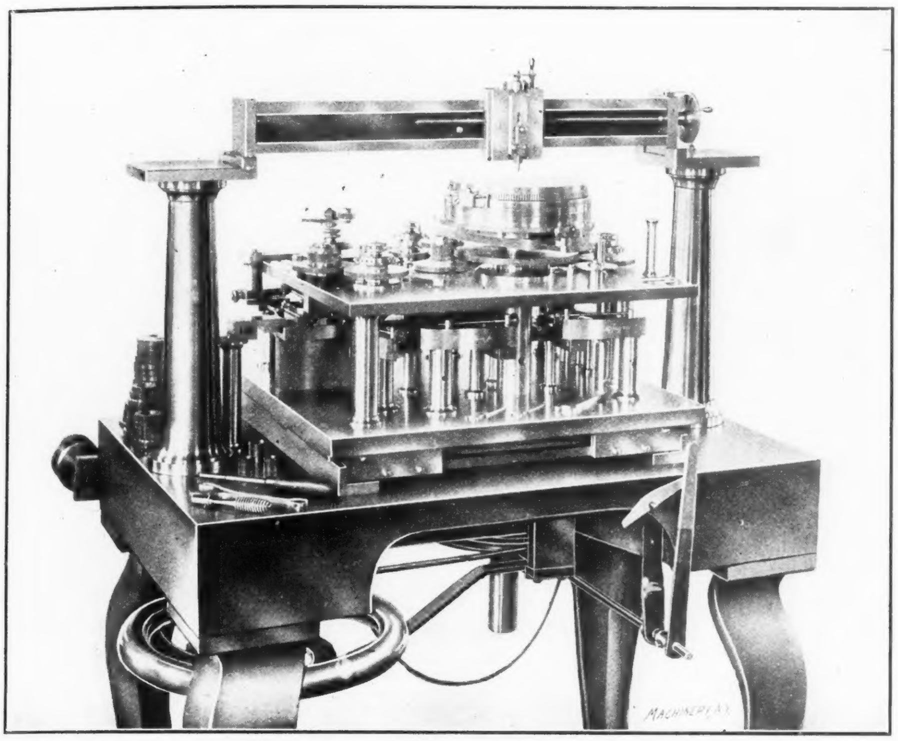

Fig. 7. Improved Dickinson Geometric Lathe.

geometric figures, by means of combinations of gears, cams and eccentrics. Over twenty million different patterns have already been counted off, and the end is not yet reached. In fact, with his latest improved lathe, Fig. 7, Mr. Dickinson claims to be able to get almost any movement desired.

At the corner of a treasury note, the figure denoting its denomination rests upon an ornate design in the shape of a heart, trefoil, a hexagon, an oval or some other design composed of wave lines finer than hairs. Down in the corners you will find the words "five," "two," or the letter "V" or figure "2" printed upon the same little lacy figure made up of the finest lines. Turn the bill over and you will find the lacy figures repeated in groups or borders, almost entirely covering the back. Look at the little green band around a box of cigars or a bag of tobacco, and somewhere upon it appears similar combinations of circles and wave lines. Every treasury note, every revenue stamp, postage stamp, bank bill or bond carries these fine lined creations, and each of a different combination so as to make it difficult to counterfeit. In fact the design in each corner of the face of every bill is different, thus multiplying the difficulty. The die to be engraved is clamped to the top platen or chuck of the lathe. The hardened steel cutting tool—sometimes pointed with a diamond—is fastened in a stationary position on the cross-beam shown at the top of the lathe. The working of the lathe is like fairy fingers. There is no noise—only a slow movement or series of movements of the platen holding the die. The die follows the directions necessary to produce the pattern. Each pattern is calculated mathematically from the degree of a circle. Sometimes it will take two months to make a shell or die of the most intricate patterns. Ordinarily it takes four or five days to complete one of the small designs in the corner of a bill. Not only is the distance from each line measured, but the depth to which the tool is to go. The cutting tool is adjustable vertically, and after a given series of movements is completed, the tool is adjusted and a deeper cut taken. The average number of cuts on each movement is about twenty. Having had one row or thread of the figure cut upon it, a shadow of change in the adjustment of the lathe is made, and now the movement may perhaps be from the center to the rim of the design, in and out, over and over again. There are only about twenty of these lathes in existence, and they are owned by the United States and foreign governments, or by the bank-note companies, and it is safe to say that they are the product of either the Dickinson shops, or those of the W. H. Chapman Co., which are also located at Newark. It is unnecessary to add that the U. S. Secret Service keeps a close watch on where new lathes go, as well as the plates that are turned out on them.

While the operator of the geometric lathe has been turning out his lacy designs, the hand engravers have been busy with the portrait work and lettering, and when all the separate dies are completed they are then ready for the transferrer, whose methods of operation are described in the fore part of this article.

The Transfer Press.

The transfer press, which is used for transferring the separate designs from the dies to the soft steel rolls, and thence back to the flat plates as a completed design, is an important machine in this work. It not only is an aid to the government in its policy of having each part of a treasury note engraved by a separate person, but on bonds and other work of this character, it effects a wonderful saving in time, as it enables several engravers to work on various parts of a design at

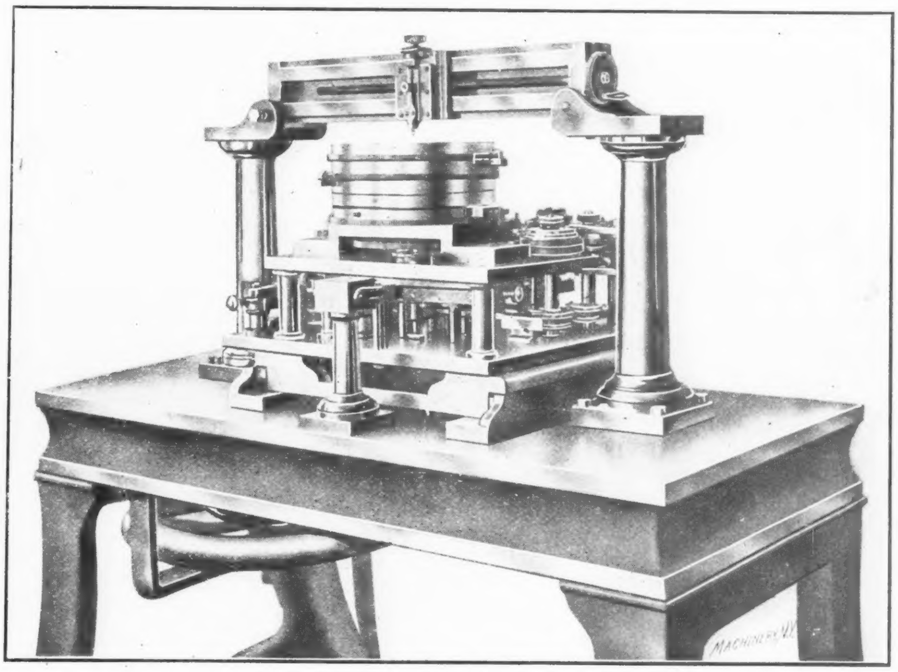

Fig. 8. Geometric Lathe made by W. H. Chapman Co.

one time; these are then assembled by means of the transfer press into a complete design. It would take a great many months to complete a design if the original engraving were all done on one plate, and each engraver would be required to wait for the other to finish before he could start on his part of the work.

The transfer press is designed on the compound lever prin-

ciple, as will be noted on referring to the illustration. The engraved die, and the roll which is to receive the impression, are set square with each other by means of a very delicate and accurate gage seen at the front end of the large beam at the top of machine. Then the foot-lever which extends under the bed of the press is depressed and the operator, or transferrer as he is called, racks the die back and forth across the surface of the roll through the medium of the large hand-wheel on the side of the press. The shaft on which this hand-wheel is keyed, carries a spur pinion on its inner end which meshes with a rack in the bed of the press. With this style of press and its system of compound levers, great pressure can be produced, the ratio between the end of the foot-lever, where the

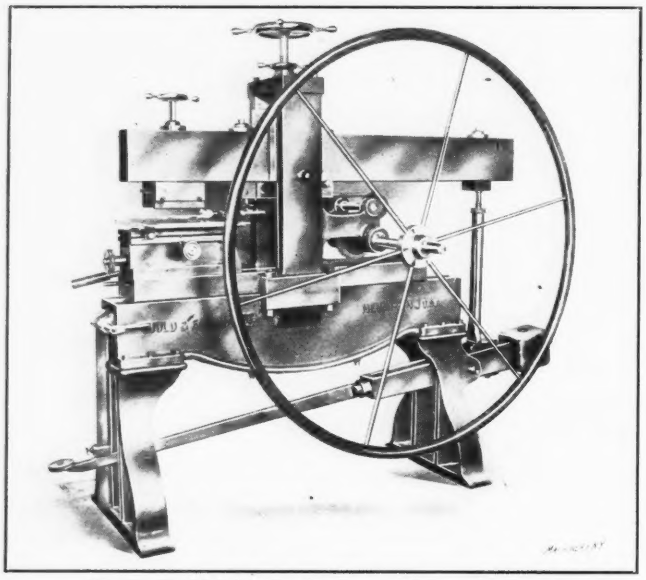

Fig. 9. Gould & Eberhardt's Improved Transfer Press.

initial pressure is applied, and the end of the beam where the roll is placed being about thirty-five to one.

At one time the government manufactured its own presses. Castings were made under the directions of the Bureau, and put together by machinists in their employ. This policy, however, was abandoned several years ago, and the government now purchases new presses when needed. Some of the first transfer presses were made by Poole & Hunt, of Baltimore, but in later years nearly all of the presses used by the bureau and the bank-note companies have been manufactured by either W. H. Chapman Co., or Gould & Eberhardt, of Newark. The latter concern has made a number of valuable improvements in the press, some of which have been patented. The original design of the press has been made more stable in construction, and more convenient for the operator, and their type of transfer press is used by the government in issuing its specifications for new machines.

The Printing Presses.

Two styles of presses are commonly employed by the plate printers for their flat work, one known as the D-roller hand press, and the other as the steam power plate press. A new press, however, has recently been designed, by which it is possible to bend up the engraved plates in circular form and print from them on this press very much like the ordinary cylinder presses. While the commercial bank-note companies find occasion to use a great many of the steam presses for their bond work, lithographing, etc., and while the government also uses them for some of its work, for the finer work, the government prefers the hand press, of which there are several hundred in use. It was long contended by expert engravers and printers that the fine effects attained by hand work could not be obtained by the steam presses, however ingenious.

This contention, however, has been disputed, and a test by inspection, was made several years ago, of work done on the two styles of presses. As a result of this, the government still continues to use the power presses. The law governing the printing of the United States money requires that it be done "in the highest state of the art," and it is safe to say that hand-operated presses will still continue to be an important factor in turning out the higher grades of work.

The steam presses are used almost exclusively at the Bureau for printing the backs of treasury and bank-notes, and for revenue and postage stamps. The first printing of any money is on the back. The printing of the face of the note (which is done on the hand presses) then follows. Then follows the numbering consecutively by automatic numbering machines. The final process is the imprint at the treasury of the seal of the Treasury Department, which makes the money valid. The signatures of the Treasurer and Register of the Treasury are printed in fac-simile, and not signed as many suppose. The national bank-notes, however, are signed in ink by the president and cashier of each bank.

The special paper used comes from the Treasury Department dry. It is then counted and prepared in the damping room for the presses. Women in the damping room receive so much paper each morning, count the sheets and give receipts for them. Layers of sheets are laid between layers of wet cloths, twenty sheets to a cloth, and then subjected to a strong pressure. When the sheets are turned over to the printer, his woman assistant counts them and certifies to the number, which certificate is witnessed by the printer, who thus in turn becomes responsible. Lock-boxes, attached to each press, register automatically every sheet printed. During the process of printing, before the plate is inked, it is warmed over a gas stove which is attached to the press. The plate is then inked thoroughly, so that the ink fills all of the engraved depressions. The surplus of ink is next rubbed off with a cloth, and it is finally rubbed off with the hand and polished with a whiting substance. The assistant lays on the sheet, and the final impression is made. This seems a slow process, and yet each hand printer and his assistant average from 800 to 1,000 impressions a day, each sheet containing four bills.

The functions of the steam power plate press are practically the same as those of the hand press, with the exception that the different operations are nearly all performed automatically by the press itself. The steam press consists of a large, square table, with four "planks' on which the engraved plates are carried. Sometimes only one plate is used at a time, and at

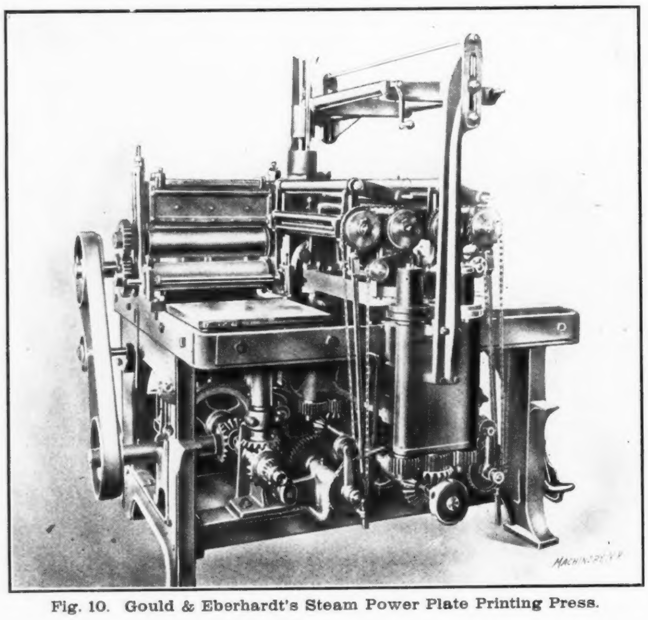

Fig. 10. Gould & Eberhardt's Steam Power Plate Printing Press.

others any number up to the capacity of the press, which is four plates. These plates are automatically and continuously carried around each side of the press by means of an endless chain, bringing them successively under the inking and printing rolls. One man and three women assistants are required to operate it. After the plate is inked by the machine, an automatic wiper removes the surplus ink, leaving but very little hand polishing to be done. One of the assistants then lays the sheet on the plate, which passes under the printing roll, after which the sheet is removed by another assistant, and the plate continues on to complete another cycle. The speed with which the plate is carried around the press varies with the work to be done, and can be regulated to suit. The number of impressions, however, average from eight to ten a

minute. After printing, the sheets are put in lock-boxes, and are taken by messengers in lots of 200 to the Examining Division, where they are counted and certified. If the count is correct, they are put in perforated racks and wheeled into the drying room where they are dried by artificial heat.

Just before the last stage of the work, and after printing, the sheets are placed between heavy sheets of cardboard, and subjected to hydraulic pressure. The pressure is 5,000 pounds to the square inch on money, checks and postage stamps, and 4,500 pounds on the revenue stamps. The next step is to take the sheets to the numbering room, where they are trimmed and numbered. Finally they are put up in packages of 1,000 sheets and placed in the receiving vault of the Bureau, where they are kept until transferred to the Treasury Department. Each sheet has been counted more than fifty times, and it takes about one month to complete the printing.

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HIGH-PRESSURE TURBO-COMPRESSORS.

ALFRED GRADENWITZ.*

Centrifugal ventilators, until a short time ago, were used for compressing air only in the case of pressures inferior to 1 m. (40 inches) water. The introduction of steam turbines and high-speed electric motors reaching very high speeds of rotation, however, made possible the use of turbo-compressors even in the case of rather considerable pressures. The first successful turbo-compressors of this kind were designed

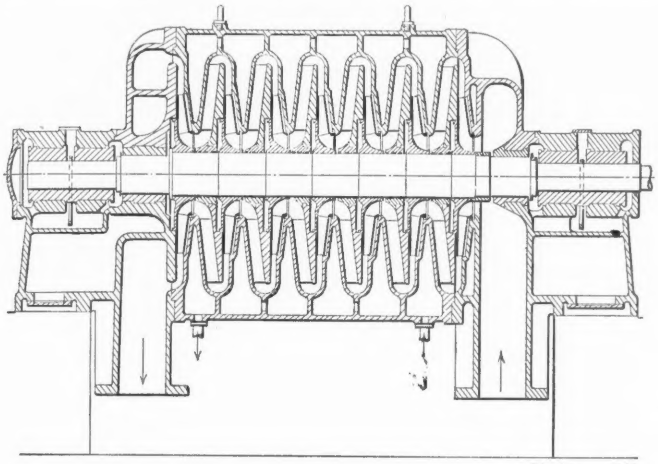

Fig. 1. Longitudinal Section of Rateau Turbo-compressor, showing Cooling Chambers.

by Prof. A. Rateau of Paris, and are exactly analogous to the centrifugal pumps constructed by the same engineer.

In Fig. 1 is shown a longitudinal section of a multiple-rim compressor unit cooled by water injected between the various cells. The rotating rims are made of steel. Especially remarkable is the construction of the diffusers, the cross-sections of which are U-shaped channels surrounding the partitions. Fixed vanes are placed in the section of the channel, conveying the fluid toward the center, and sometimes also in the centrifugal section. These U-shaped diffusers are largely the cause for the high efficiency of this type of centrifugal apparatus. In order to avoid any leakage, the outside bearing is made entirely enclosed.

The cooling of the air to be compressed is a very important question in the case of pressures of compression exceeding, say, twice the initial pressure. Whereas, in the first compressors constructed by Prof. Rateau, a system of cooling analogous to surface condensing plants between each two successive compressor units was employed, a less expensive solution has been suggested by M. René Armengaud, *viz.*, simply to cool the compressor housing. This arrangement is represented in Fig. 1.

In the compressors recently constructed, a further advance has been made in this connection, fresh water being introduced into the partitions (which to this effect are hollowed out) and even into the diffuser vanes. The cooling surface is thus augmented considerably, and the heating of the air is reduced in proportion, so as to bring the working of the machine even closer to an isothermal cycle than that of reciprocating compressors.

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From the numerous efficiency tests made by Prof. Rateau on turbo-compressors of recent construction, it is inferred that very high pressures can be obtained with efficiencies approaching 60 per cent, which is a figure quite comparable to those applying in the case of good reciprocating compressors. When cooling the compression by a water circulation round the compressor housings, even higher figures can be obtained, the working cycle coming very close to that of isothermal compression, though at a temperature far superior to that of the sucked-in air. The efficiency in this case reaches figures as high as 63 per cent.

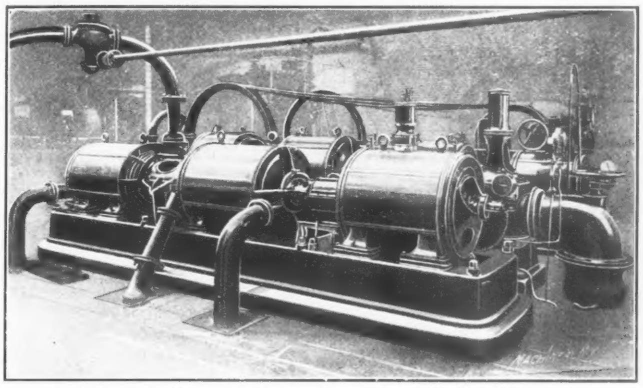

Fig. 2. Rateau Turbo-compressor for the Bethune Mines.

While the efficiency of turbo-compressors and reciprocating compressors thus is about equivalent, the former type of compressor possesses a number of advantages over the latter. The dimensions of the new type of compressor are obviously far smaller than those of ordinary compressors. A very striking instance is quoted by Rateau, *viz*: the turbo-ventilator of Commentra, which takes up a total area of 75 square feet, whereas the blowing machine for which it was substituted took up an area more than twenty times greater, or 1,760 square feet. The centrifugal apparatus also is of far smaller weight, and as its vibrations are quite immaterial, it obviously requires far less substantial foundations.

A further advantage is the extraordinary simplicity of construction and relative cheapness of centrifugal compressors. Again, there are no working expenses worth speaking of, due to the consumption of lubricating oil, the only parts subject to friction being the bearings of the shaft. As no oil enters the interior of the apparatus the compressed

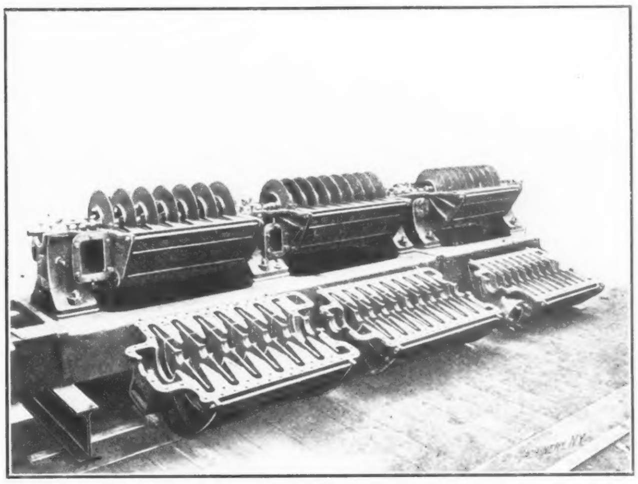

Fig. 3. Rateau Turbo-compressor built by Brown, Boveri & Co., to be driven by Gas Turbine.

gas does not contain any, which in some cases may be important.

The perfect regularity of the air current yielded by turbo-compressors is another good point as compared with the pulsations produced by reciprocating compressors which necessitate the installation of compensating reservoirs.

The output of a centrifugal compressor is obviously regulated readily within wide limits, by slightly varying the speed, or by opening and closing a gate in the suction or compression conduits, whereas, in the case of reciprocating compressors, a similar result could be obtained only by controlling the speed of the motor.

No accident need be feared in case one of the conduits becomes obstructed, as the compressor continues to turn freely with the consumption of energy reduced in proportion. The safety valves, which are quite indispensable in the case of reciprocating compressors, are, therefore, superfluous. In spite of the elasticity of output, the turbo-compressor allows a constant output as well as a constant pressure to be insured. The regularity of the motor is, in fact, controlled without difficulty by a special apparatus which acts on it in the case of any variation of the output or pressure. The regulators constructed to this effect by Rateau are of remarkable simplicity and are absolutely reliable in operation.

The possibility of coupling turbo-compressors directly to electric motors or to steam turbines without any intermediary gearing, is another advantage of centrifugal compressors, resulting in a diminution of friction losses. The exhaust steam from other engines, operating low-pressure steam turbines of the Rateau system, can thus be utilized for the production of compressed air, by combining a steam accumulator with a turbo-compressor driven by low-pressure steam. Compressed air can, for instance, be produced in mining plants and in metallurgical works exclusively by the aid of the exhaust steam from the winding engines or rolling mills, respectively. A striking instance of this economical scheme is found in the Béthune mines, and will be described in the following, and many other plants of the same kind are in course of construction. In this special field the old type of compressor will obviously be quite unable to compete with the newcomer, which may be called an ideal machine for a satisfactory utilization of exhaust steam. On the other hand, it should be borne in mind that turbo-compressors would be less satisfactory in the case of small outputs and low speeds of rotation. A few typical instances of plants constructed by Prof. Rateau and his licensees will be described in the following.

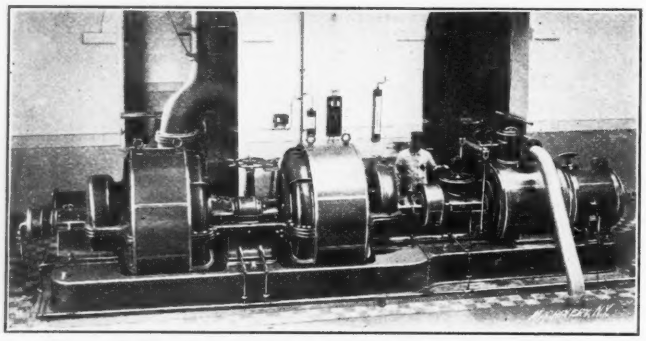

Fig. 4. Rateau Turbo-compressor at the Chasse Blast Furnaces.

The turbo-compressor installed at the Béthune mines, which has just been referred to, serves to compress air to 6 and even to 7 atmospheres (88 to 103 pounds per square inch) by utilizing the exhaust steam from the winding engine. This machine (Fig. 2), which has been in regular operation since May, 1906, is made up of four multi-cellular units, traversed by the air, in series. These units are arranged in groups of two each on two parallel shafts, each of which is actuated by a low-pressure turbine. A high-pressure turbine fitted to one of the shafts does not do any work under normal conditions, and is used only as reserve in the case of interruption in the supply of exhaust steam, when an automatic apparatus will open the entrance conduit of the boiler steam to the high-pressure turbine, the exhaust of which is conveyed toward the low-pressure turbine. Another automatic apparatus is intended for uniformly distributing the charge between the two shafts. Between each two consecutive compressor units are inserted cooling devices, traversed by the cold water which is supplied by a small centrifugal pump mounted on the same shaft.

This plant, at a speed of 5,000 turns per minute, has been found to yield 32 cubic feet of air per second, the pressure of compression being 100 pounds per square inch above the atmospheric pressure. This is the highest figure so far obtained with centrifugal compressors.

The efficiency of the first three compressor units is especially remarkable, being as high as 70 per cent, while in the case of future applications it is hoped to raise the efficiency of the last unit to the same figure.

A compressor of even greater size, Fig. 3, has been constructed in 1906 by Brown, Boveri & Co. This is intended for operation by the aid of an Armengaud petrol turbine, and consists of three units mounted on the same shaft, the cooling of the air being effected during compression by a water circulation surrounding the compressor units. This compressor has been designed for drawing in 39 cubic feet of air per second in order to compress this to an absolute pressure of 71 pounds per square inch at a speed of 4,000 revolutions per minute.

Another turbo-compressor, Fig. 4, which was constructed by Sautter Harlé & Co., has been in operation at the Chasse blast furnaces since the month of March, 1907. This is calculated for yielding 255 cubic feet per second (this volume being reduced to atmospheric pressure) at a pressure of 11¾ inches mercury. The same plant is capable, in the case of any irregularity in the working of the blast furnace, of yielding 141 cubic feet per second at a pressure of 23½ inches mercury. To this effect the compressor has been divided into two identical units, which can be coupled up either in quantity or in series. The speed of rotation is 3,000 revolutions per minute. This machine is provided with an apparatus for recording its output, so as to ensure a perfect regularity.

As regards the numerous turbo-compressors in course of construction, the centrifugal blowers constructed by the Gutehoffnungshütte should be mentioned in the first place. These are intended for being operated by electric motors of up to 2,000 H. P. Brown, Boveri & Co., on the other hand, have received orders for about 10 turbo-compressors, one of which (of 1,500 H. P.) will be used for the compression of air to 120 pounds per square inch absolute. Some of the compressors planned for the blowing-in of Bessemer converters will have a capacity of even more than 4,000 H. P.

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POWER TRANSMISSION BY FRICTION DRIVE.*

A friction drive, as the term is employed in the following, consists of a fibrous or somewhat yielding driving wheel, working in rolling contact with a metallic driven wheel. The drive may consist of a pair of plain, cylindrical wheels mounted on parallel shafts, or of a pair of beveled wheels, mounted on shafts at right angles. In the following, the results of tests with such drives are summarized.

Wheels Tested.

Wheels of the following materials have been tested in the experiments referred to: Straw fiber; straw fiber with belt dressing; leather fiber; leather; leather-faced iron; sulphite fiber; and tarred fiber.

The straw fiber wheels were worked out of blocks, built up of square sheets of straw-board, laid upon one another, with a suitable cementing material between them, and compacted under heavy hydraulic pressure. In the finished wheel the sheets appear as disks, the edges of which form the face of the wheel. The wheel of straw fiber, with belt dressing, was similar to the one described, excepting that the individual sheets of straw-board were treated with belt dressing before being converted into a block.

The leather fiber wheel was made of cemented layers of board, consisting of ground sole leather cuttings, imported flax, and a small percentage of wood pulp. The leather wheel was composed of layers or disks of sole leather. The leather-faced iron wheel consisted of an iron pulley, having a leather strip cemented to its face. After less than 300 revolutions, the bond holding the leather face failed, and the leather separated itself from the metal of the pulley. The wheel proved incapable of transmitting power, and no tests were recorded. The wheel of sulphite fiber was made up of sheets of board, composed of wood pulp. The tarred fiber wheel was made up of board, composed principally of tarred rope stock, imported French flax, and a small percentage of ground sole leather cuttings.

* Abstract of paper by W. F. M. Goss, read before the American Society of Mechanical Engineers, December meeting, 1907.

Each of the wheels was tested in combination with driven wheels of iron, aluminum, and type metal. All the wheels tested, both driving and driven, were 16 inches diameter, the face of the driving wheels being 1¾ inch, while that of the driven was ½ inch. The purpose of the experiments was to secure information for formulating rules regarding the power which may be transmitted by friction between fibrous and metallic wheels. To accomplish this, it was necessary to determine for each combination the coefficient of friction under varying conditions, and the maximum pressures of contact which could be withstood by the fibrous wheels.

Results of Tests.

The results of the experiments involving the straw fiber driver and the iron driven wheel, show that although the values of the coefficient of friction for 400 pounds pressure per inch width of wheel were slightly lower than those for 150 pounds pressure, the results were sufficiently similar to establish the fact that the law governing the change in the coefficient of friction, with slip, is independent of the pressure of contact. With a 2 per cent slippage the coefficient of friction for the pressures mentioned varied between 0.410 and 0.425.

Experiments with the straw fiber driver and aluminum-driven wheel show that the coefficient of friction with a working pressure of 150 pounds per inch width of wheel, and a slippage of 2 per cent is 0.455, and that for all pressures ranging from 100 to 400 pounds, the coefficient of friction is practically constant, when the rate of slip is constant. With a type metal driven wheel, the coefficient was 0.310.

Wheels of straw fiber, treated with belt dressing, and of iron, worked together with a pressure of 150 pounds per inch width of wheel and with a slip of 2 per cent with a coefficient of friction of 0.12, the friction remaining practically constant up to a pressure of 400 pounds per inch width of wheel.

The coefficient for 150 pounds pressure per inch width of wheel between leather fiber and iron, and a slip of 2 per cent equals 0.515. The same material with aluminum shows a friction coefficient of 0.495, and with type metal, 0.305.

The coefficient of friction between an iron wheel and one of tarred fiber, with a slip of 2 per cent, and a pressure of 150 pounds per inch width of wheel, equals 0.220, and for a pressure of 400 pounds per inch, 0.250. Aluminum and tarred fiber show a coefficient of friction of 0.305 for a pressure of 150 pounds, and a coefficient of 0.295 with a pressure of 400 pounds per inch width of wheel. With type metal the coefficients for 150 and 400 pounds are 0.275 and 0.270, respectively.

The coefficient of friction between leather and iron with a slip of 2 per cent and a pressure of 150 pounds per inch width of wheel equals 0.225, and for a pressure of 400 pounds, 0.215. A leather driver may be successfully operated up to a pressure of 750 pounds per inch width of wheel. With aluminum, the coefficient of friction proved to be 0.260 and 0.295 for 150 and

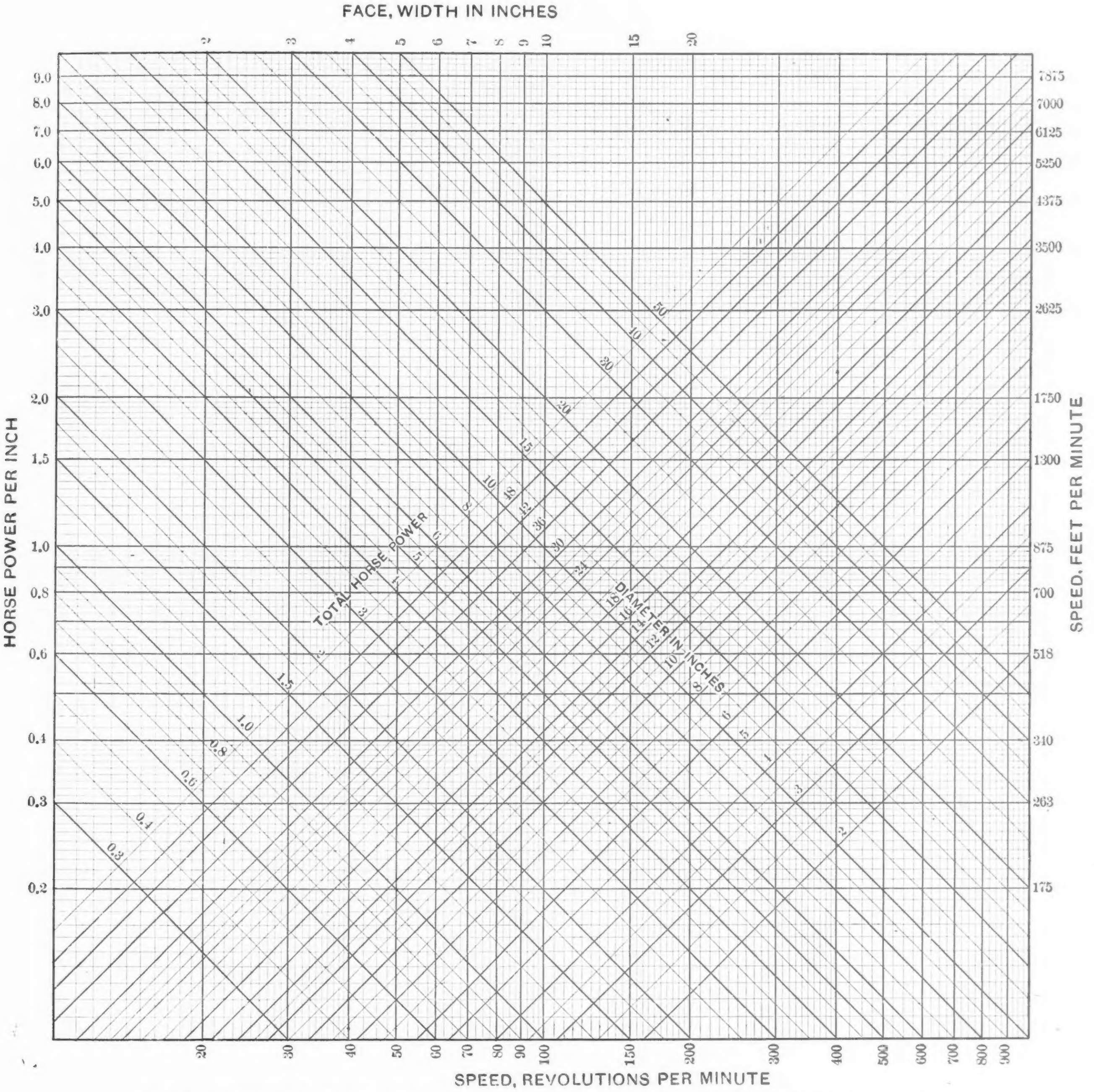


Chart for Determining the Horse-power Transmitted by Straw-fiber Friction Wheels working against Iron Wheels.

300 pounds pressure, respectively. Running with type metal, the leather showed a coefficient of friction of 0.410, with a pressure of 150 pounds per inch width of wheel.

Sulphite fiber proved to have a coefficient of friction of 0.550 for a pressure of 150 pounds, and was successfully operated up to a pressure of 700 pounds per inch width of face. The coefficient of friction for this material running with aluminum was 0.410, with a pressure of 150 pounds; and when running with type metal, the coefficient of friction was 0.515 for the same pressure.

Tests were also undertaken to demonstrate the maximum pressure per inch width of face, which each wheel could stand. These experiments showed that hardly any of the wheels would decrease in diameter under a pressure of 200 pounds per inch width of face, but when the load was increased, a decrease in diameter followed. For straw fiber wheels and a pressure of 750 pounds, the decrease in diameter was 1/8 inch. Leather fiber proved to stand pressures to a far greater extent. A pressure of 800 pounds per inch width of face compressed the diameter of the wheel less than 1/16 inch, and it took 1,100 pounds pressure to compress it as much as 1/8 inch. Tarred fiber wheels decreased in diameter more than 1/8 inch when the pressure reached 800 pounds, and the leather wheels, when the pressure reached 550 pounds. Sulphite fiber decreased nearly 1/16 inch in diameter with a pressure of 400 pounds, and more than 1/8 inch with a pressure of 600 pounds.

General Conclusions.

The relative value of the metal drive wheels is not the same when operated in combination with different fibrous driving wheels. Driving wheels which are more dense, work more effectively with an iron follower than with either aluminum or type metal followers, but the softer and less dense driving wheels work better with aluminum and type metal than with iron.

The relative value of the different fibrous wheels, when employed as drivers of a friction drive, show that the addition of belt dressing to the composition of the straw fiber wheel is fatal to its frictional qualities. The highest frictional qualities are possessed by the sulphite fiber wheel, but, on the other hand, it is the weakest of all the wheels tested. The leather fiber and tarred fiber wheels are the strongest, and the former possesses also frictional qualities of a superior order. The plain straw fiber, which in a commercial sense is the most available of all materials, possesses frictional qualities which are far superior to leather, and strength which is second only to the leather fiber and the tarred fiber.

As safe working pressures of contact, the following figures may be given:

Material.	Pounds per inch of Width of Face.
Straw fiber	150
Leather fiber	240
Tarred fiber	240
Sulphite fiber	140
Leather	150

For *working values* of the coefficient of friction, the following figures may be considered correct:

Type of Drive.	Coefficient of Friction Working Value.
Straw fiber and iron	0.255
Straw fiber and aluminum	0.273
Straw fiber and type metal	0.186
Leather fiber and iron	0.309
Leather fiber and aluminum	0.297
Leather fiber and type metal	0.183
Tarred fiber and iron	0.150
Tarred fiber and aluminum	0.183
Tarred fiber and type metal	0.165
Sulphite fiber and iron	0.330
Sulphite fiber and aluminum	0.318
Sulphite fiber and type metal	0.309
Leather and iron	0.135
Leather and aluminum	0.216
Leather and type metal	0.246

Horse-power Transmitted.

Having now determined the safe working pressure of contact, and a representative value for the coefficient of friction, it is possible to formulate equations expressing the horse-power which may be transmitted by each combination of wheels tested. In these equations let

d = diameter of friction wheel in inches,
W = width of face of friction wheel in inches,
N = number of revolutions of friction wheel per minute,
H.P. = number of horse-power transmitted.

The formula would then be:

$$\text{H.P.} = k\,d\,W\,N$$

in which equation k is a coefficient which for the various materials is as follows:

Type of Friction Drive.	Coefficient.
Straw fiber and iron	0.00030
Straw fiber and aluminum	0.00033
Straw fiber and type metal	0.00022
Leather fiber and iron	0.00059
Leather fiber and aluminum	0.00057
Leather fiber and type metal	0.00035
Tarred fiber and iron	0.00029
Tarred fiber and aluminum	0.00035
Tarred fiber and type metal	0.00031
Sulphite fiber and iron	0.00037
Sulphite fiber and aluminum	0.00035
Sulphite fiber and type metal	0.00034
Leather and iron	0.00016
Leather and aluminum	0.00026
Leather and type metal	0.00029

A convenient means for finding the horse-power transmitted is supplied in the chart shown. This chart, in fact, gives a diagram for determining the value of *any one* of the variable factors in the formula H. P. $= 0.0003\,d\,W\,N$ for the straw fiber friction wheel working in combination with an iron follower, the remaining factors being known or assumed. To transform values thus found to corresponding ones for the other possible combinations of wheels, it is only necessary to multiply by the proper factor chosen from the table of multipliers given above. The use of the chart may be illustrated as follows:

TABLE OF MULTIPLIERS FOR FINDING HORSE-POWER OF FRICTION DRIVES.

Type of Friction Drive.	Multiplier.
Straw fiber with iron	1
Straw fiber and aluminum	1.10
Straw fiber and type metal	0.73
Leather fiber and iron	1.97
Leather fiber and aluminum	1.90
Leather fiber and type metal	1.17
Tarred fiber and iron	0.97
Tarred fiber and aluminum	1.17
Tarred fiber and type metal	1.03
Sulphite fiber and iron	1.23
Sulphite fiber and aluminum	1.17
Sulphite fiber and type metal	1.13
Leather and iron	0.53
Leather and aluminum	0.87
Leather and type metal	0.97

a. To find surface speed, locate the intersection of the vertical line representing the given speed in revolutions per minute with the diagonal one representing the given diameter. The horizontal line passing through this point will give the surface speed in feet per minute on the vertical scale to the right of the diagram.

b. To find the horse-power for a given wheel, locate the intersection of the vertical line representing the given speed in revolutions per minute with the diagonal line representing the given diameter. Follow the horizontal line passing through this point to the right or left until the intersection between it and the vertical line representing the given width, as shown on the scale at the top of the diagram, is reached. The diagonal line passing through this point marked "Total horse-power" will represent the required horse-power.

c To find the face width of a given wheel, necessary to transmit a given horse-power, the speed being known, locate the intersection of the vertical line representing the given speed in revolutions per minute with the diagonal line representing the given diameter. Follow the horizontal line passing through this point to the right or left until the intersection between it and the diagonal line representing the required horse-power is reached. The vertical line passing through this point will give the width of face in inches on the scale at the top of the diagram.

* * *

It is stated that, at the present time, there are in the United States 700 steam turbines in use, representing 1,500,000 horse-power.

GEAR-CUTTING MACHINERY.—2.

RALPH E. FLANDERS.*

This installment continues the description of the formed milling cutter type of machine for cutting spur gears, the automatic gear-cutter of orthodox design being under consideration.

Another well-known tool in this field is that shown in Fig. 24. It is built by Gould & Eberhardt, Newark, N. J. In this machine, as in the Flather machine, the column is double and the work carrying head passes through it. This machine is of larger capacity than any of the others shown so far, and in common with most large capacity machines, is provided with a mechanism for raising and lowering the work spindle head by power. Another point of interest in this machine is the automatic clamping feature with which it is provided, used for firmly holding the rim of the blank being cut while the cut is in progress. This is in addition to the usual positive back stop against which the blank rests. This clamp consists of a pair of jaws, carried by slides on the adjustable arm shown at the front of the machine. This arm is set to bring the jaws in position to clasp the rim of the gear being cut. The jaws are operated by a screw connected with the mechanism of the machine in such a way as to hold the work firmly while the cut is in progress, releasing it while the indexing takes place, and again clamping it for a new cut. It is especially useful for comparatively slender work.

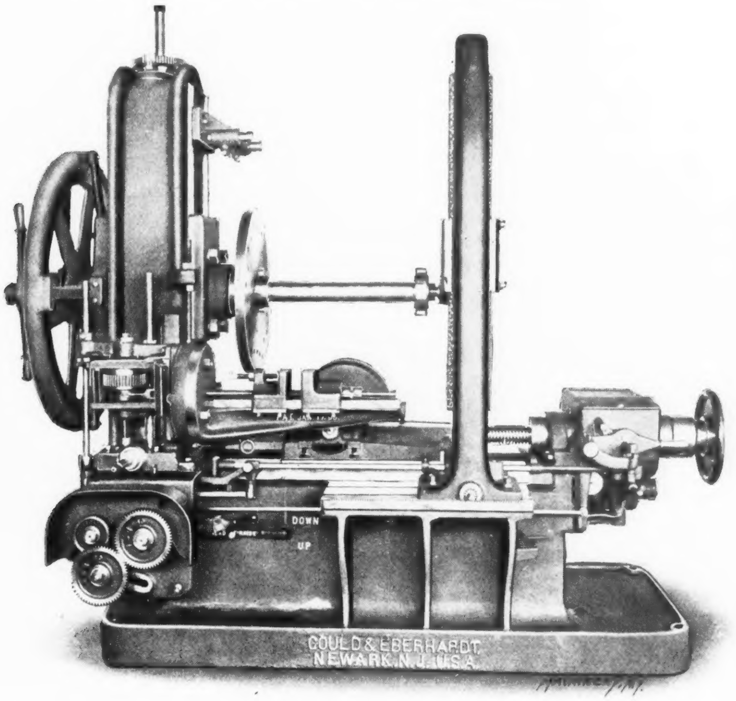


Fig. 24. Gould & Eberhardt Spur Gear Machine, with Special Automatic Rim Clamping Device Attached.

The general features of this line of machines can be best seen by referring to Fig. 25, which shows another member of this line, specially constructed for the severe service of cutting steel motor gears. The cutter and feed screw are in line with each other, so that a direct central thrust is imparted to the slide. The machine is driven through a single pulley, from which the movement is transmitted through gearing and keyed shafts to the different parts of the machine. This insures a large and constant area of belt contact at all speeds. The cutter spindle is driven by worm and worm-wheel through change gearing. The index wheel is of the split rim type with hobbed teeth, the final finishing of which is done with the dividing wheel in position on the machine. Means are provided for compensating for all wear and lost motion which may take place in this mechanism. A slight tension is constantly maintained between the stop cam and the worm in the direction of rotation, which prevents all danger from back lash and rebound. The rigid construction of the outer support of the work arbor will be noticed. Its base is mounted on a bracket cast on the side of the main frame. In removing a finished gear from the machine, it can be moved back out of the way without disturbing the height adjustment of the outboard bearing.

An automatic gear-cutter of continental design and manufacture is shown in Fig. 26. This tool is built by Ludwig Loewe & Co., of Berlin, Germany. Its most striking feature, so far as appearance is concerned, is the provision made for supporting the outer end of the work arbor. Two uprights are used, one at the front and the other at the rear of the bed, supporting a bearing for the work arbor. This bearing is counterweighted, so as to be easily adjustable for vertical position. The uprights can be moved back when it is desired to insert the work, by operating the hand-wheel shown at the base of the front one. The spindle of this machine is driven by a worm-gear. It has a dividing wheel of large diameter for the range of work it is intended for, it having a diameter of 57 inches, and being made in two parts, by the method which generates each wheel anew, rather than making it a copy of a previously made master wheel. Eight changes of feed are provided, varying from .010 to 0.42 inch per revolution of the cutter. This machine is also built in two smaller sizes; the size shown will cut gears up to 78 inches in diameter.

The machine shown in Fig. 27 is built by J. Parkinson & Son, Shipley, England. This machine cuts gears up to 48 inches in diameter by 10 inches face. The cutter spindle is driven by a worm and worm-gear, and has four changes of speed obtained by a sliding quick change gear arrangement, instead of by the usual removable gears. The dividing mechanism is driven by friction, and has a device which starts and stops it gradually to avoid shock. The gradual starting and stopping is done by the interposition of a pair of elliptical gears which gradually increase the rapidity of the indexing movement when it is started, and retard it in the same way as it is being completed. Provision is made also for preventing the feeding of the cutter into the work if a wrong division takes place. By means of suitably arranged connections, provision is made for multiple indexing, which is often resorted to, to avoid local heating. In cutting a gear having 47 teeth, for instance, every fourth tooth may be cut continuously, until the gear is completed. In this way, the heat due to cutting

Fig. 25. Specialized Design of the Gould & Eberhardt Automatic Gear-cutter for Heavy Motor Gear Work.

* Associate Editor of MACHINERY.

is distributed more uniformly around the rim, avoiding the distortion due to local heating, which is liable to occur when teeth are cut in regular order. This multiple indexing is obtained without requiring the change gears to be specially calculated for it.

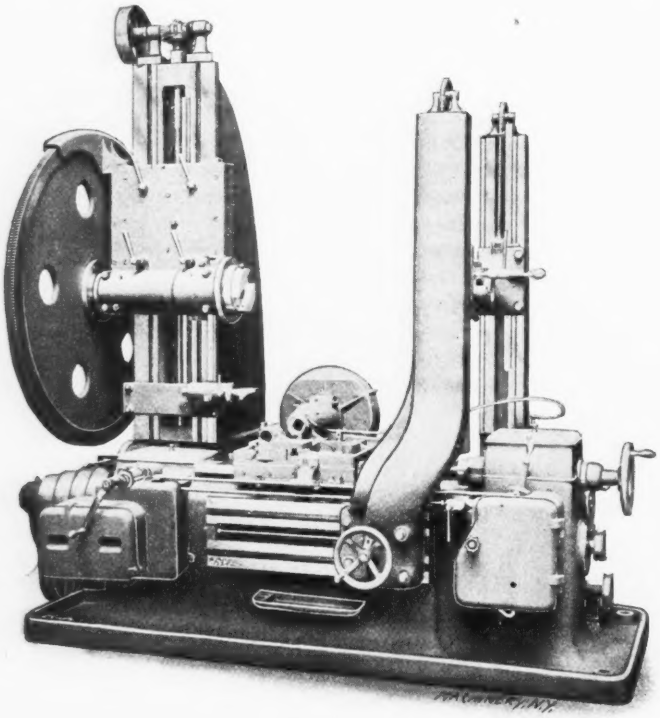


Fig. 26. The Largest Size of the Line built by Ludwig Loewe & Co.

A gear-cutter made by J. E. Reinecker, of Chemnitz-Gablenz, Germany, is shown in Fig. 28. The index wheel of this machine is of large diameter, about 7/10 of that of the largest gear that can be cut. The mechanism controlling the movements of the machine is so arranged that the forward feed does not commence until the indexing has been completed, the cutter slide being retained in its rearward position until that

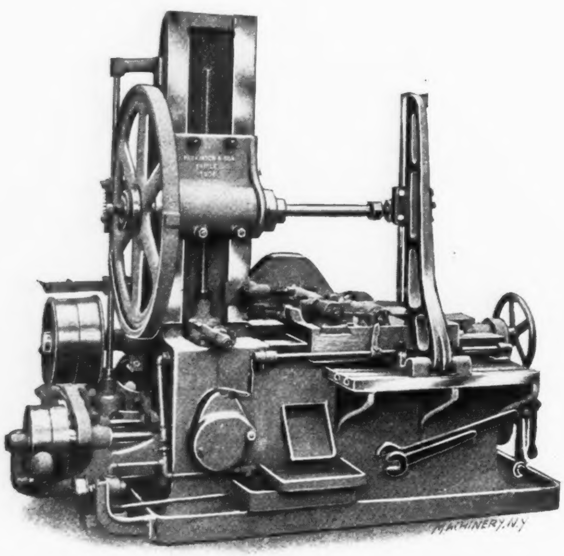


Fig. 27. An Example of English Design, built by J. Parkinson & Son.

time, thus avoiding the possibility of damage to the machine or work from failure of the mechanism to operate properly. An unusual feature of the machine, seen in the view shown, is the spindle drive gearing. The spindle is driven by a worm. This is not of the ordinary type, with a hole through its center, splined to be driven by the longitudinal driving shaft on which it slides as the table is fed forward or back; instead, a long worm is used, fixed longitudinally, and threaded for a sufficient length to accommodate the worm-wheel throughout the full travel of the slide. It will also be observed that the outboard support for the work arbor is hinged to facilitate the insertion and removal of the work.

A gear-cutter built by Messrs. G. Wilkinson & Son, of Keighley, England, is shown in Fig. 29. This is essentially the same in principle as the previous machines described, but it has an entirely different appearance, due to the fact that the bed is set on legs, instead of extending down to a solid bearing on the floor. The controlling mechanism is also somewhat differently arranged, although the movements required are the same. It will be seen that it is intended for comparatively small work. It takes wheels up to 18 inches in diameter and 6 diametral pitch. The cutter spindle is driven by a spur gear of large diameter.

Conventional Type of Automatic Formed Cutter Machine for Heavy Work.

The machines we have just been describing are representative of the standard form of automatic machine for small and

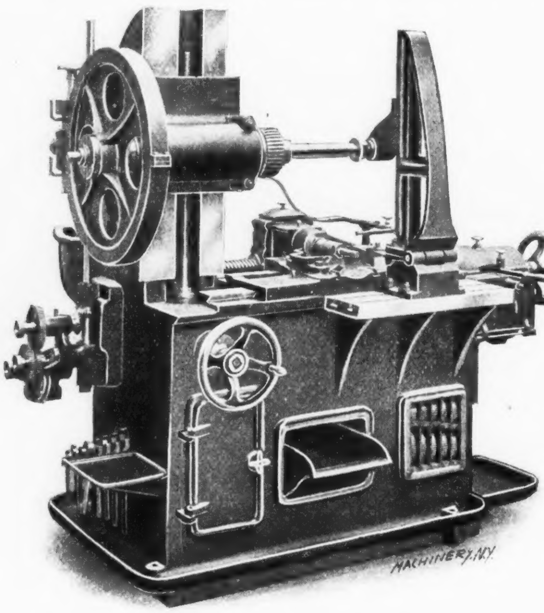


Fig. 28. The Reinecker Automatic Spur Gear Cutting Machine.

medium work. Considerations of ease of handling the work and convenience in arranging the mechanism, have evolved a somewhat different form of machine for the largest and heaviest work. The change made may best be described by saying that the previous type of machine is laid down on the back of its column, with the bed extending vertically upward into

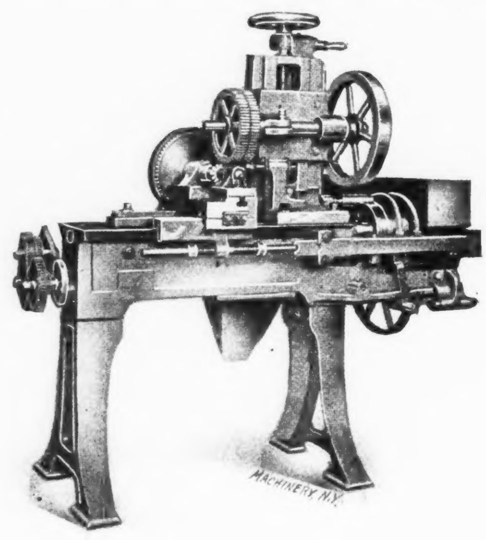


Fig. 29. The Wilkinson Automatic Machine for Small Gears.

the air. In other words, the change is simply a change of base. The bed becomes the column, and the column becomes the bed. This explanation will be easily understood by comparing the machines shown in Figs. 33 to 36 with those in Figs. 21 to 28. The principal advantage due to the change

of base in this machine is the better support given to heavy work, the weight of which is carried directly by the bearing of the slide on the bed, instead of being taken by the elevating screw in the column, as in the design previously discussed.

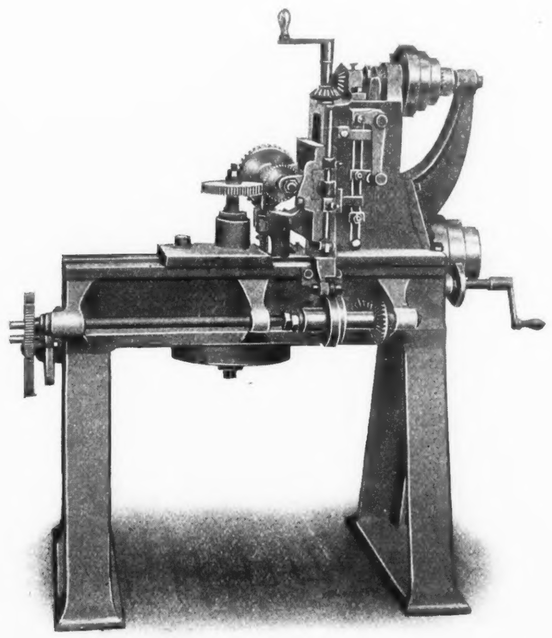


Fig. 30. A Small Armstrong Whitworth Automatic Machine.

Although it was stated that this design was especially adapted for heavy work, the first three machines here shown of this kind are comparatively small. That shown in Fig. 30 is built by Sir W. G. Armstrong Whitworth & Co., Manchester, England. The machine is very simple in design and ruggedly

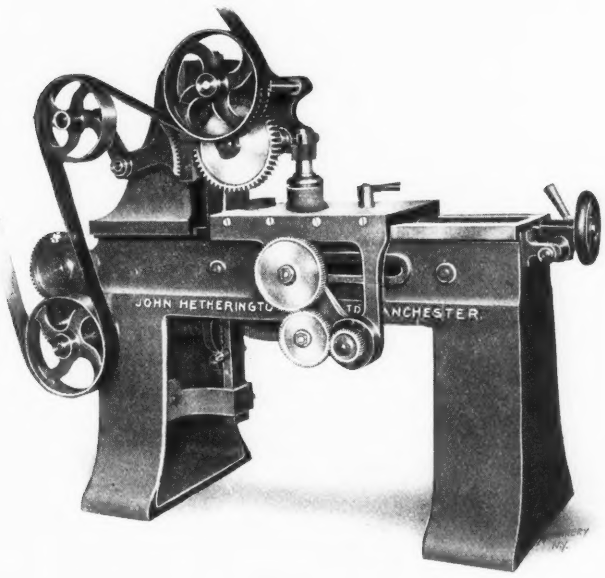


Fig. 31. A Simple Machine with Cam-operated Feed, built by John Hetherington & Sons.

built. The slow downward feed and quick return is obtained by epicyclic gearing in the feed cone at the top of the column. The clutches controlling this mechanism are operated by stops on the side of the column operated by the slide. The indexing mechanism is of the frictional type set by change gears for the required number of cuts.

The gear-cutting machine shown in Fig. 31 is built by John Hetherington & Sons, Ltd., of Manchester, England. A number of interesting points are evident from the cut. For instance, as may be seen, the vertical feed of the cutter slide on the face of the column is effected by a cam under the base, at the end of the horizontal bearing in the rear leg. This cam, and the roller and slide which it operates, are plainly visible beneath the machine. The slide is counterweighted to keep the roll always pressed up against the cam. Another ingenious detail of the mechanism is the belt tightener provided, which compensates for the change in position of the cutter slide. The belt is passed over an idler fastened to one end of a bell crank, whose other arm has teeth engaging a rack on the cutter slide. As the slide descends, requiring more belt, the idler moves toward the right, furnishing the required amount. The same belt drives both the spindle mechanism and the feed mechanism. The index worm and wheel are beneath the table. A quick withdrawing motion operated by an eccentric lever is provided for bringing the spindle back from the cutter when it is desired to remove or replace work on the arbor; this can be operated without disturbing the setting for depth of cut. This machine will cut gears up to 30 inches in diameter, 4 inches face and 4 diametral pitch. The proper change gears for varying the feed and indexing are furnished with the machine.

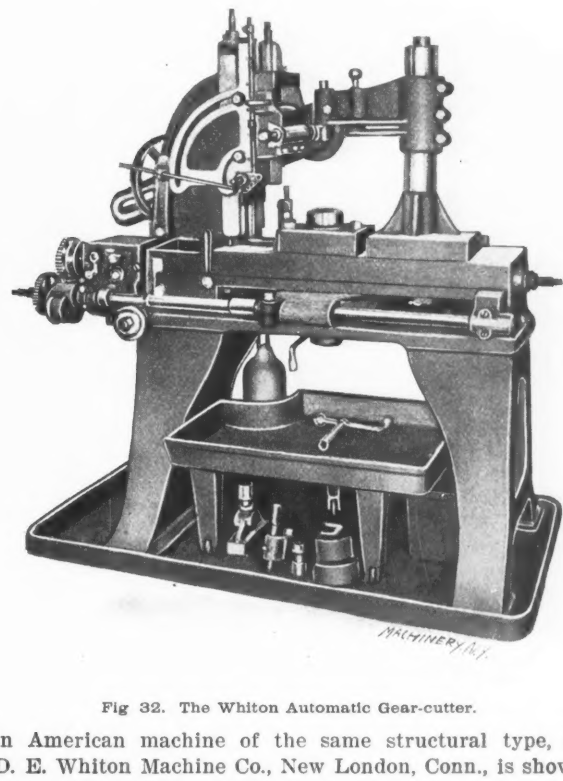


Fig 32. The Whiton Automatic Gear-cutter.

An American machine of the same structural type, built by D. E. Whiton Machine Co., New London, Conn., is shown in Fig. 32. It is fully automatic, and one of the features of its mechanism is a provision for making the starting of each movement dependent on the successful completion of the previous one. That is to say, the mechanism is so arranged that

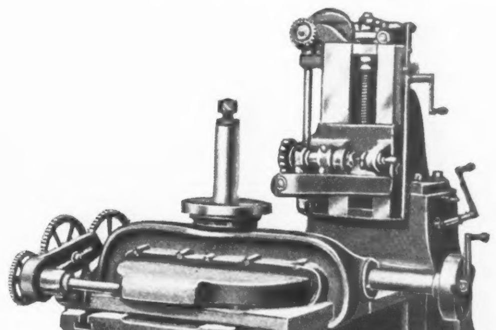


Fig. 33. Heavy Armstrong Whitworth Gear-cutting Machine.

the reverse feed is locked until the forward feed has been completed, the indexing is locked until the reverse has been properly indexed. There are no frictional devices, and but one stop adjustment—that for length of stroke, which also releases the indexing device. Unlike other machines of this type to be described, this one is arranged for cutting bevel

gears as well, the cutter slide being mounted on an adjustable sector which may be set to the cutting angle of the bevel gear which is to be milled.*

The first of the heavier machines here shown in Fig. 33 is another built by Sir W. G. Armstrong Whitworth & Co., of Manchester, England. In this machine the index wheel is carried above the bed, while a second bearing for the work spindle is provided by the arm which springs from the work slide on either side, and spans the index wheel. This brings the top of the base rather low, so the column is carried on an upward extension of the bed, giving the whole structure a distinctive appearance. The change gears for indexing are mounted on the slide, and carried with it when adjustment is made for diameter. In this machine the indexing is either automatic or hand, as may be thought best. There is less gain in automatic indexing in very heavy work than in the medium size, since the time of feeding is proportionately longer, while the large machine should have at least as much attention as is required for indexing. The cutter head of this machine can be set on an angle if desired, for gashing worm-wheels. The cutter spindle is supported at the outer end by a bearing and is driven by a coarse lead worm-gear. The machine is

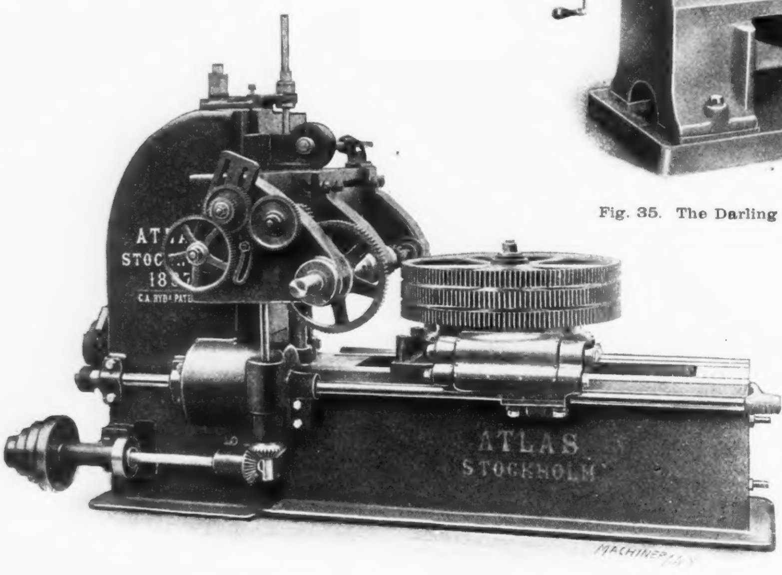


Fig. 34. An Example of Swedish Design—The Atlas Machine, as arranged for Cutting Spur Gears.

adapted to the cutting of wheels from 12 to 96 inches in diameter, up to 14 inches face.

The machine shown in Fig. 34, built by Nya Aktiebolaget Atlas, Stockholm, Sweden, is shown cutting a stack of large spur gears. It is in reality, however, a universal machine, being adapted to making spiral and worm-gears as well as spur gears, so that it has mechanism in addition to that needed for cutting spur gears only, as may be seen from the cut. The heavy cross rail and the change gearing mounted on it are part of the mechanism required for hobbing worm-wheels. Its action as a spur gear machine is automatic and similar to that of the machines previously described. Like the Armstrong machine in Fig. 33, it has the index wheel above the bed. The machine will cut gears up to about 8 feet in diameter. Other applications of this tool will be described later.

The machine shown in Fig. 35, built by Darling & Sellers, Keighley, England, has the index wheel carried below the bed with the work spindle passing up through it. It will also be noted that the work carriage encircles the bed, having bearings on its sides, as well as being gibbed at top and bottom. The cutter spindle is driven by spiral gearing, and the head is counterbalanced. The spindle is hardened and carried in a long taper bearing, which is

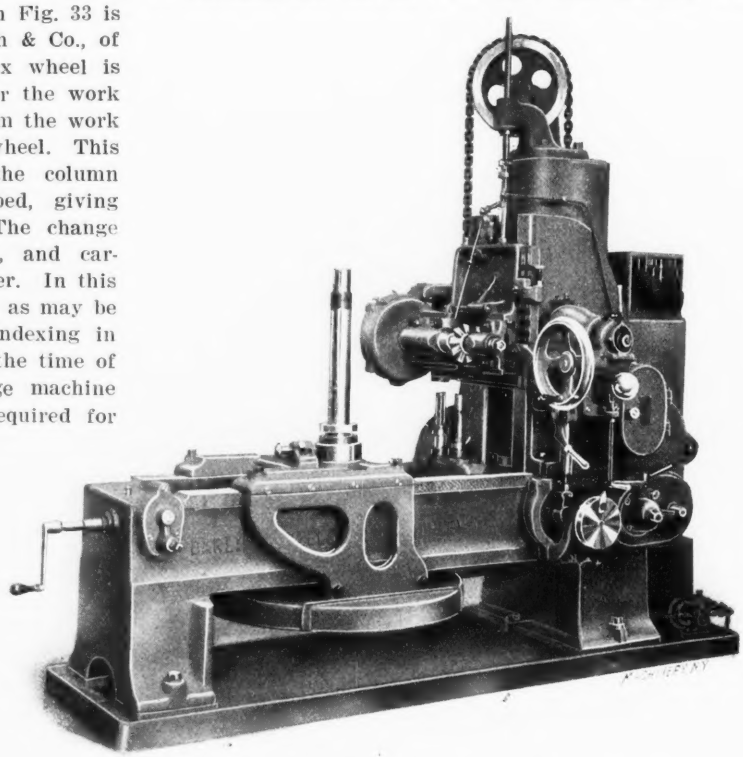


Fig. 35. The Darling & Sellers 4-foot Automatic Spur Gear Cutting Machine.

carefully ground to fit. The endwise adjustment for centering the cutter is effected by moving the main spindle bearing bodily to the left or right. A permanent gage is attached to the cutter slide which can be instantly lowered to test the centering of the cutter. A novel feature of this gear-cutting machine is the way in which the quick return of the cutter slide is effected by the excess

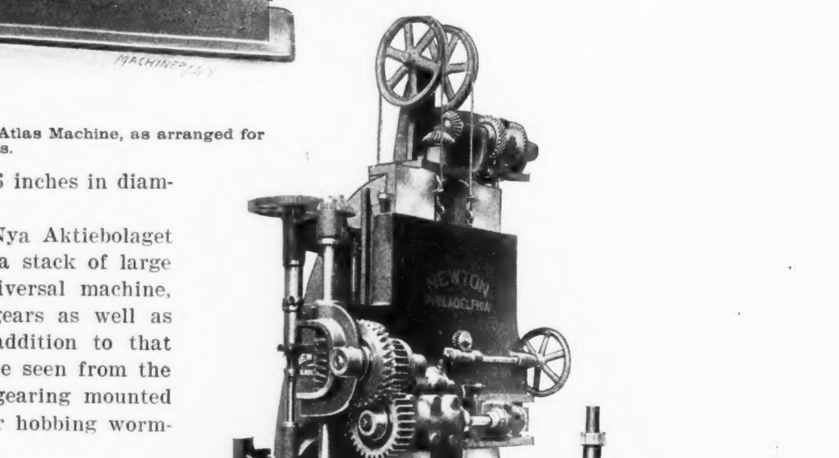


Fig. 36. A Newton Machine, especially designed for the Cutting of Heavy Motor Gears and Pinions.

weight of the counterbalance, which returns the slide immediately to its upper position when the feed is released, stopping against an air cushion. The feed change is accomplished by

* See article entitled "A New Automatic Gear Cutter" in the January, 1898, issue of MACHINERY.

change gearing. The indexing device is of the friction type, but so interlocked with the feeding mechanism as to prevent the feeding of the cutter before the indexing has been completed. A larger size of this machine is provided with a clamping arrangement which firmly holds the rim of the work while the cut is being taken. This works automatically; a friction drive acting through a screw presses it down onto the work, while a positive clutch raises it again. The machine shown in the cut has a feed of 16 inches and will swing a 4-foot gear. The whole design of the machine is unusually interesting and attractive.

In Fig. 36 is shown an automatic gear-cutting machine built by the Newton Machine Tool Works, Philadelphia, Pa. This is intended especially for the cutting of heavy gears made of high carbon steel, such as are used in motor gears for electric cars, locomotives, etc., with the expectation of cutting two or three teeth at once. The massive proportions of the machine give evidence of the duty for which it is intended. It is provided with a mechanism which renders it impossible to engage the downward feed until the dividing has been successfully completed for the next tooth. The machine shown is directly motor-driven, the spindle being connected to the motor through a train of spur, spiral, and worm-gearing. The indexing worm-wheel is mounted above the slide, as may be seen.

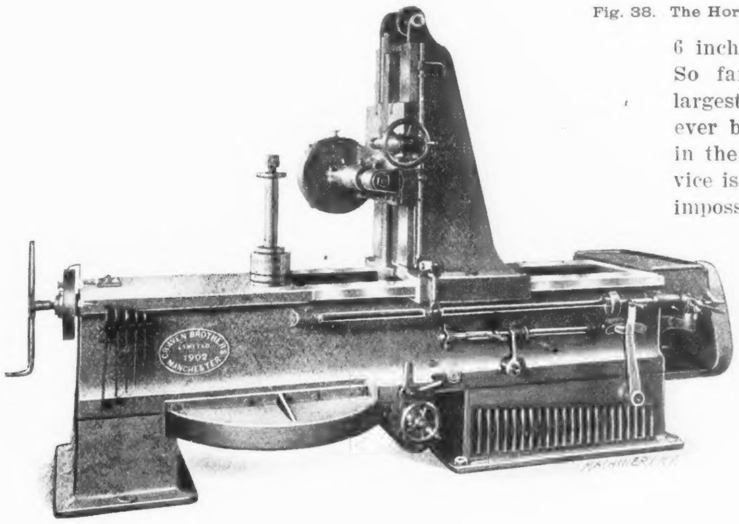


Fig. 37. The Craven Automatic Gear-cutting Machine.

Machines for Heavy Work with Column Adjustable for Diameter.

A common modification of this type of machine consists in making the column carrying the cutter slide adjustable on the bed to suit the diameter of the work, instead of adjusting the work spindle. A machine thus arranged, built by the Newton Machine Tool Works, has been illustrated in these columns.* It is not automatic, however, since it requires that the indexing be done by hand.

An automatic machine of this type is shown in Fig. 37. This tool is built by Craven Bros., Ltd., Manchester, England. The spindle head is counterbalanced, and is provided with four feeds which may be changed by the quick change mechanism seen at the front of the machine. The cutter spindle is driven by a quick feed worm and gun-metal worm-wheel. The outer end is supported in an adjustable bearing. The dividing mechanism can be operated either by hand or power. The design is a neat one and shows evidence of careful planning.

The adjustable column machine shown in Fig. 38 is built by Gould & Eberhardt, of Newark, N. J. This is the 15-foot size of a line of three, of which the largest will cut, entirely automatically, gears up to 20 feet in diameter, 36 inches face and 6 inches circular pitch in cast iron, or 4½ inches in steel.* So far as the writer knows, this latter machine is the largest entirely automatic spur gear cutting machine that has ever been built. There are a number of interesting features in the design and construction of this machine. A safety device is incorporated in the indexing mechanism which makes it impossible for the cutter to feed downward before the indexing has been successfully completed. An auxiliary cutter spindle (shown in place in the machine) is provided for finer pitch, small diameter cutters. When the heaviest work is being done, this small spindle and the boxes which support it are removed. The column has rapid power adjustment on the bed with fine hand adjustment for the final setting. This line of machines has been largely used in cutting cast iron and steel gears which had formerly been made with

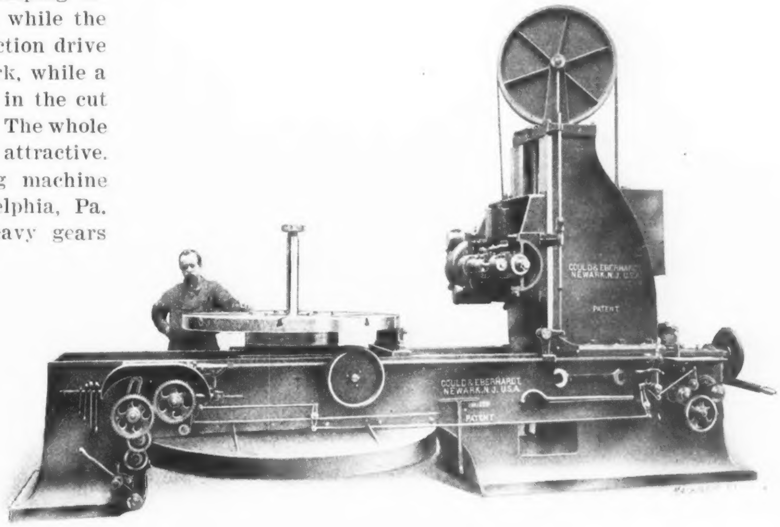


Fig. 38. The Horizontal Type of Gear-cutter, as built by Gould & Eberhardt.

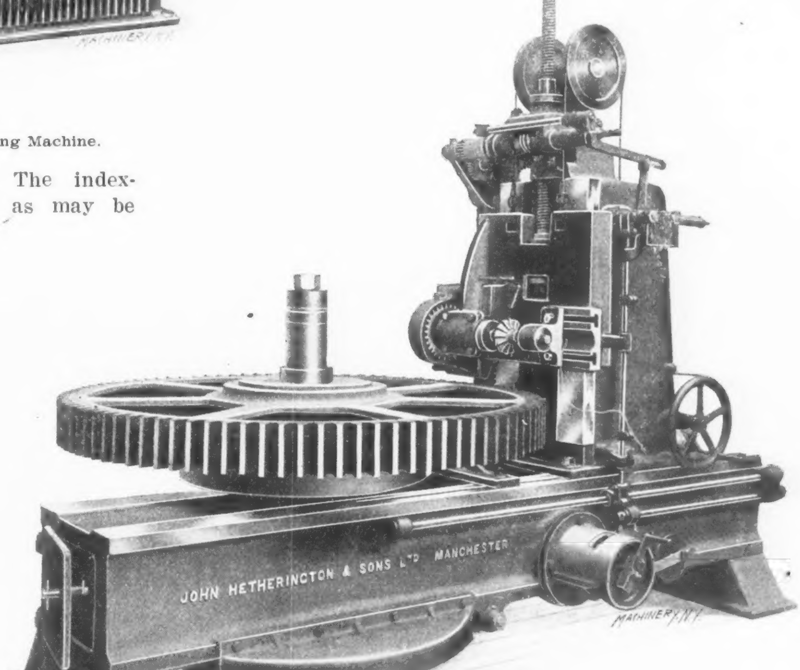


Fig. 39. The Hetherington Automatic Gear-cutting Machine.

* See article entitled "American Gear-Cutting Machinery" in the June, 1898, issue of MACHINERY.

* Described in "New Tools of the Month" section of MACHINERY, February, 1904.

cast teeth, giving very much better gears at an expense not much greater than was required with those with cast teeth.

In Fig. 39 is shown a machine of the adjustable column type built by John Hetherington & Sons, Ltd., of Manchester, England. This is a large capacity machine being fitted for cutting gears up to 8 feet in diameter, 16 inches face and 1 diametral pitch. The dividing mechanism may be operated

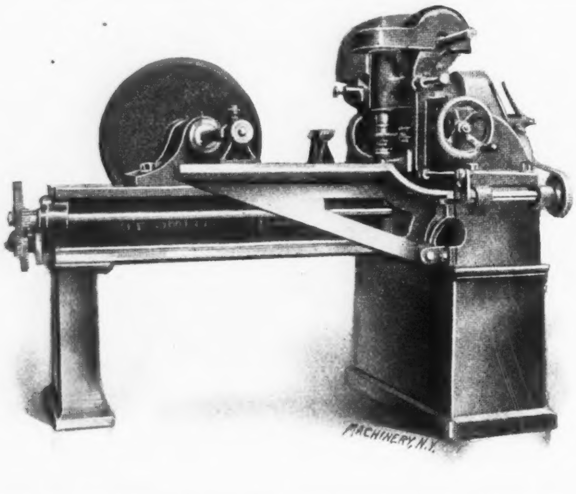


Fig. 40. An Example of Machine with L-shaped Bed, as made by G. F. Smith, Ltd.

either automatically or by hand. In the former case it is effected by means of a ratchet mechanism operated by a crank which starts the movement gradually and stops it in the same way without shock and without danger of over-running. The spindle is driven by worm and spur gears from a 3-step cone pulley for a wide belt of high velocity. The worm-gear is gun metal, and the worm of steel.

Spur Gear Cutting Machines, with L-shaped Bed.

As the machines we have been describing for heavy work were evolved from the orthodox gear-cutter by the expedient of laying that machine on its back and transforming the base into the column and *vice versa*, so a third type, occasionally met with, has resulted from laying the orthodox machine on its side, producing a bed having an L-shape. The Pratt & Whitney gear-cutting machine was an example of this. This is familiar to most mechanics engaged in gear-cutting, as there are many of them in use in various shops in this country for cutting spur gears and hobbing worm-wheels. The builders have discontinued making the machine, however, so we do not show it here.*

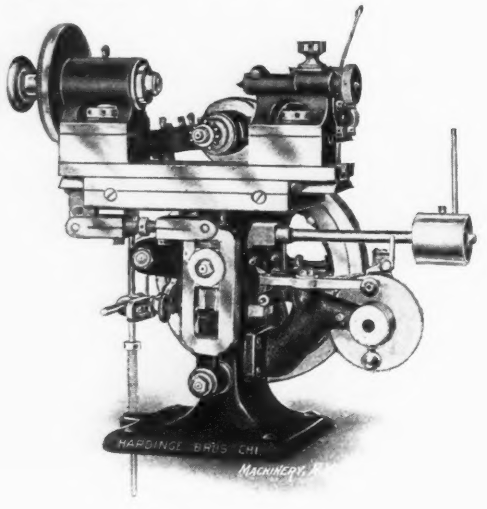


Fig. 41. The Hardinge Automatic Precision Gear-cutter.

Fig. 40 is an example of this type. Here is shown an automatic gear-cutter built by G. F. Smith, Ltd., of Halifax, England. As may be seen, one branch of the L furnishes ways on which the horizontal work spindle is adjusted to set the machine for the proper diameter of work. The other portion of the bed furnishes ways for the slide carrying the vertical cutter spindle. This cutter spindle is driven by spiral and worm-gearing from a counter-shaft cone. The indexing worm on the dividing wheel shaft is adjustable in the center to take up wear. All changes of feed and indexing are by positive gearing. An outboard support for the work spindle is plainly shown in the cut attached to the outer end of the cutter portion of the bed.

Another example of this type of machine, though arranged with adjustments permitting the cutting of bevel gears, is that built by Messrs. G. Wilkinson & Son, Keighley, England; it will be shown in a succeeding installment of this article.

Precision Machines using the Formed Cutter.

The machines we have described are suited for the cutting of gears ranging from those used in machinery of ordinary size, up to the largest and heaviest built. There has been a development along somewhat different lines, in machines for cutting teeth in minute pinions and gear blanks, such as are used in watches, fine instruments, etc. Some of these small machines cost as much as, or more than, larger ones for ordinary work. This is due in part perhaps to their complexity, but more to the accurate fitting necessary. An amount of looseness which would be just sufficient to provide oil space in the spindle of a large automatic gear-cutting machine, would give so loose a fit to the spindle of one of these minute mechanisms as to make it totally unfit for the work it has to do. Where the thickness of the teeth of the gear being cut is a matter of a few thousandths only, the required accuracy in the fitting of the spindle, slides, etc., must be expressed in tens of thousandths or even hundreds of thousandths of an

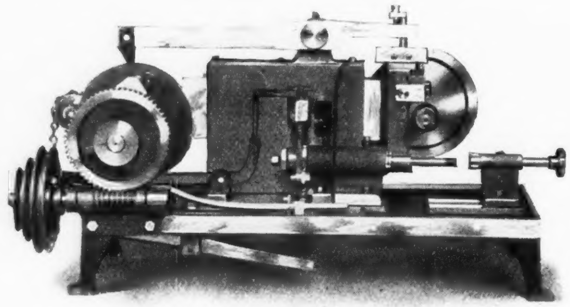


Fig. 42. The Standard Mfg. Co.'s Automatic Precision Gear-cutter.

inch. Even though a high degree of accuracy in fitting is obtained in these machines, it is still found necessary in some cases to take two or three and sometimes more cuts through each tooth space, in order to make sure that the desired outline is obtained. In one of the machines shown, provision has been made for this.

In Fig. 41 is shown a precision gear-cutting machine built by Hardinge Bros., 1036 Lincoln Ave., Chicago, Ill., it will be seen to follow somewhat in its mechanism the Slate, and Sloan & Chace machines, shown in Figs. 18 and 19, being derived in form from the ordinary or column type for milling machines, though greatly reduced in size. In adjusting for diameter, however, the cutter spindle is moved up or down by swinging about its fulcrum, the arm on which it is carried; the table or slide carrying the work head-stock and foot-stock is not adjustable vertically for this purpose. The feeding and indexing movements are effected by a cam shaft driven by the large wheel shown at the back of the machine. The feeding is governed by the slotted link mechanism at the front, connected by the adjustable reach rod shown with the bracket extending downward from the work table, beneath the dividing head. Index plates are used instead of the index worm-wheel common in larger machines. Separate disks are used for locating the spindle and locking it in position after the indexing, the disk for the latter purpose being covered to prevent accidental injury. An arrangement is provided by which the cutter is lowered from the cut on the backward movement to prevent injuring the finished tooth space, and to allow the indexing to take place without loss of time. The ratchet wheel shown below the machine at the right is indexed

* See article entitled "American Gear-Cutting Machinery" in the June, 1898, issue of MACHINERY.

a step for each tooth cut in the work, and may be set to lower the cutter out of the work and stop the feeding mechanism when all the teeth have been cut. The cutter spindle still runs, however, and the indexing still proceeds, so that the working parts are constantly kept at the working temperature.

In Fig. 42 is shown a precision gear-cutter made by the Standard Mfg. Co., of Bridgeport, Conn.* This machine

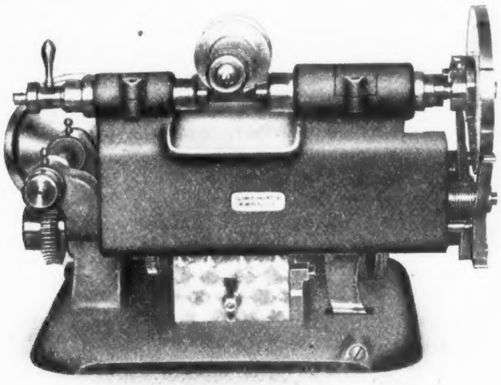


Fig. 43. The Sloan & Chace Automatic Precision Pinion-cutter, arranged for taking Three Cuts through Each Tooth.

has the indexing and feeding mechanisms operated by a cam shaft driven by the worm and worm-wheel shown at the left of the machine. It will cut gears up to 4 inches in diameter in stacks 2 inches long. As in the previous machine, the cutter is raised out of the work while the blank is being indexed and the feed is being returned to commence the next stroke. Two speeds are provided for the cutter spindle, and nine feeds. The cutter works ninety per cent of the time, the indexing and returning movements being very rapid. Both the work and cutter spindles have tapered bearings which can be compensated for wear.

The machine shown in Fig. 43, built by the Sloan & Chace Mfg. Co., Newark, N. J.,† is built on the same general plan as the previous machines so far as concerns the use of dial plates for indexing, and cams for performing the various movements. This machine, however, can be arranged to carry three cutters on the spindle, if desired. The first cutter is used for roughing, the work being indexed clear around for that purpose. The cutter spindle is then shifted endwise to bring the second cutter central with the work, when the operation is continued as before. The spindle is then shifted a

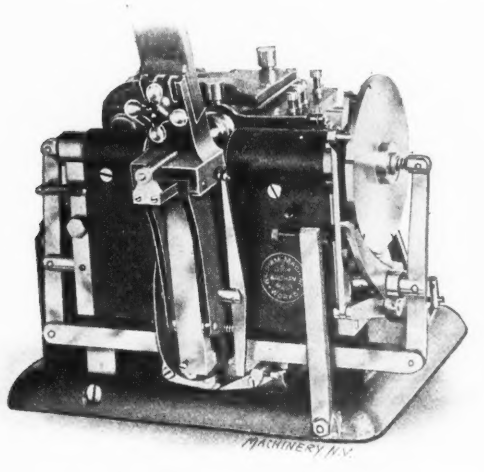


Fig. 44. The Waltham Automatic Pinion-cutter, with Magazine and Self-feeding Mechanism.

second time to bring the third or finishing cutter into position for operation, whereupon the work is completed. This little machine is ingeniously arranged to allow all three of the settings, the roughing, secondary and finishing, to be separately adjusted for centering the cutter and depth of cut. All the movements are entirely automatic. The machine is

* See "New Machinery and Tools" section of MACHINERY, May, 1907.
† See article entitled "Making Small Relieved Gear-Cutters in the Sloan & Chace Shops," January 1907, issues of MACHINERY.

essentially a pinion-cutter rather than a gear-cutter, as it is best adapted for gears having comparatively few teeth.

The automatic pinion-cutter shown in Fig. 44 is made by the Waltham Machine Works of Waltham, Mass. In this machine the automatic principle has been developed to a high degree, in that the machine feeds itself and takes out the work as well, after it is completed. The long slide seen extending upward from in front of the cutter is a magazine in which pinion blanks are placed. This magazine is brought in line with spindles of the head- and foot-stock, which (by the action of the cams by which they are controlled) grasp the shanks of the blank and hold it firmly in position to be cut. The cutting and indexing then proceed as in previous machines. When the indexing has been completed, the hold of the chucks on the work is released, and the work ejected. This operation is continuous as long as the cutter stays sharp and the magazine is kept full.

The Formed Tool Principle applied to the Grinding or Abrasion Process.

The only representative of this process, so far as we know, is the machine shown in Fig. 45. This tool, built by Upton & Gilman, Lowell, Mass.,* is intended primarily for smoothing up teeth of cast gears, so perhaps it does not really belong in the category of gear-cutting machines; as the only representative of its class, however, we have included it. The grinding wheel is formed to the shape of the tooth space of the gear to be finished. The gear is mounted on the vertical

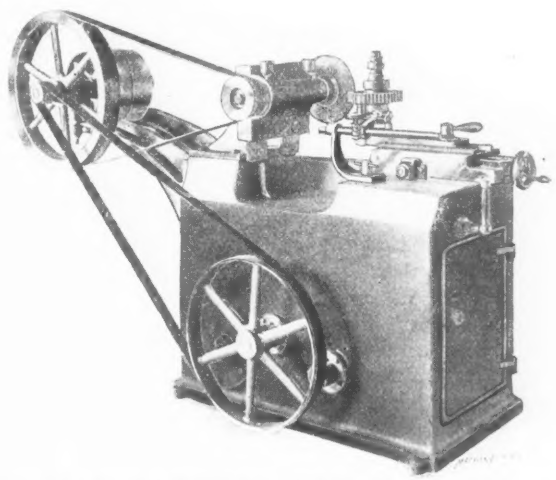


Fig. 45. The Upton & Gilman Machine for Finishing the Teeth of Cast Gears by grinding with a Formed Wheel.

spindle shown. When the machine is in operation the emery wheel is brought down through the tooth space, cleaning it out, and is then withdrawn. The work is indexed, and the operation is repeated. Owing to the fact that the shape of the space and the shape of the wheel are the same, the latter tends to preserve its form, being used merely to remove irregularities in otherwise perfectly shaped surfaces.

The Templet Principle applied to Cutting the Teeth of Spur Gears.

The templet principle is practically limited, in the cutting of spur gears at least, to the shaping or planing process. It has been used principally for large gears having teeth of very coarse pitch, too large to be formed by a formed tool or cutter covering the whole outline. It has the advantage over the formed cutter process of being comparatively simple in operation and adapted to special work at a minimum of expense, it being considerably cheaper to make a templet than to make a formed and relieved cutter of the same size.

Fig. 46 shows a templet spur gear planing machine built by the Gleason Works, Rochester, N. Y. In this tool the work spindle is horizontal, a pit being provided for gears of large diameter. The capacity of the machine is very great, it being adapted to cutting teeth in blanks up to 20 feet in diameter. The cutting tool is mounted in a traveling head at the right side of the machine. This traveling head is driven by a screw controlled by open and crossed belts and shifting mechanism similar to that used for a planer. The scale of

* Described in "New Machinery and Tools" section of MACHINERY, January, 1907.

the engraving is too small to show the templet mechanism clearly, but it is identical in principle with that illustrated in Fig. 2, in the first installment of this article. For varying the diameter adjustment to suit the blank being operated on, the head-stock carrying the work spindle is moved toward or away from the tool slide. The machine shown is motor driven.

Another remarkable example of templet machine for spur gears is shown in Fig. 47. In this case the tool is a modified slotter instead of being a modified Richards planer as in Fig. 46. The column part of this tool is, in fact, practically the portable slotter built by its makers, the Newton Machine Tool Works, Philadelphia, Pa.* It is mounted on a long base plate and may be set at any desired position thereon to agree with the diameter of the gear being cut. The work is supported on a rotating table which is indexed by a worm and worm-wheel operated through change gears by a separate electric motor provided for that purpose. The head may be moved back far enough to swing the work 40 feet in diameter. The templets for shaping the tooth outline are mounted in brackets on the tool head on either side of the tool-post of the portable shaper. The tool-post is pressed toward the right- or left-hand former by a spring, as may be required, and as it is fed outward by the feeding mechanism provided, it is thus shifted sidewise in such a fashion as to reproduce the outline of the templet on the teeth of the gear.

The next installment will describe the various machines and methods used for cutting spur gears by the molding generating process.

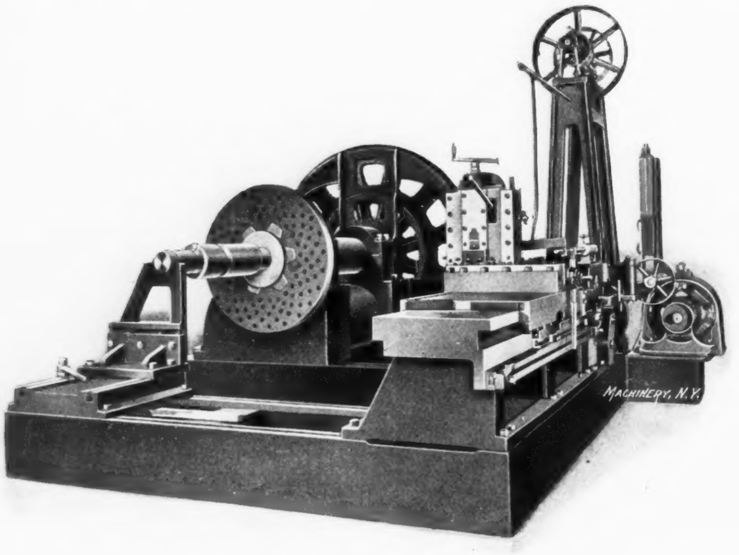


Fig. 46. The Gleason Templet Spur Gear Planer.

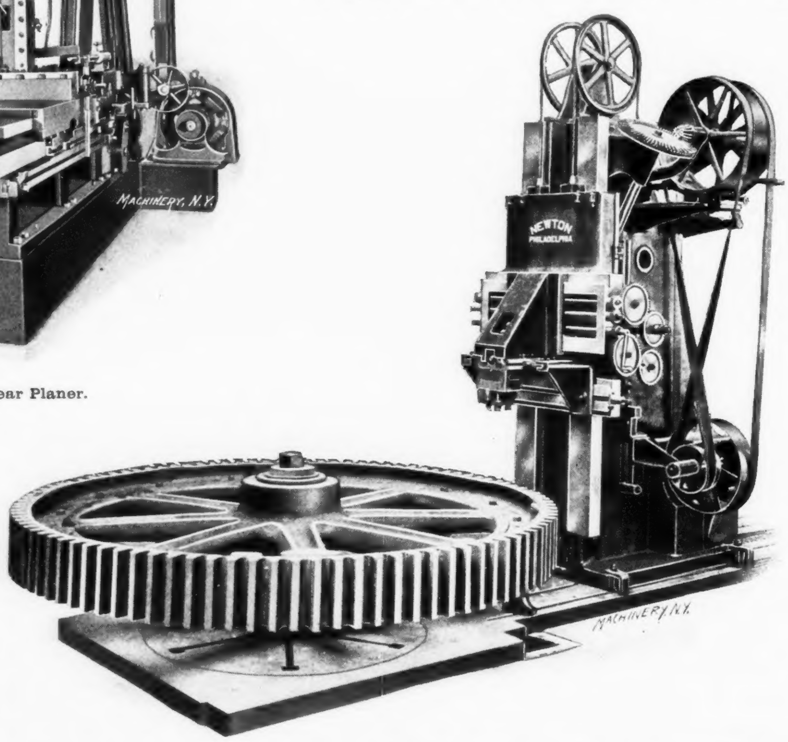


Fig. 47. The Newton Portable Slotter, arranged with Templet Mechanism and Indexing Base for Cutting Spur Gears.

* * *

NOTES ON CASE-HARDENING.

The following notes on case-hardening are from papers presented before the International Railway Master Blacksmiths' Association.

The method of case-hardening practiced at the shops of the Cincinnati, New Orleans & Texas Pacific Railroad, at Ludlow, Kentucky, was described by Mr. George Masser. The case-hardening compound used at the Ludlow shops is made by mixing 100 pounds prussiate of potash, and 50 pounds bichromate of potash, with one barrel of salt. The potash is pulverized before it is mixed with the salt. The pieces to be hardened are packed in a cast iron box of suitable size, in such a way that each piece will be covered with a sufficient quantity of potash when it is dissolved. The edges of the box lid are luted with fire clay, to make the box as air-tight as possible. The box is then placed in a furnace, where it is allowed to remain eight or ten hours, the length of time depending somewhat upon the sizes of the pieces being hardened. The pieces are cooled in a cooling tub, which is 6 feet long, 26 inches deep, and 28 inches wide. On the inside of this tub there is a screen which is made of heavy wire netting, such as is used in the front end of a locomotive. This screen is about 4 inches from the bottom of the tub, so that the cold water can circulate freely around the pieces being cooled. It is supported by angle-irons which are fastened to the sides of the tub. The screen has a bail at each end, to facilitate handling. The pieces when taken from the cooling tub, should be clean and white; if they are spotted it is an indication that the furnace was not kept at a uniform temperature.

In a paper presented by Mr. J. J. Ryan, some additional information was given on the subject of case-hardening. He has attained good results with a compound consisting of a mixture of carbonated bone black and salt. The pieces are packed in a cast iron box, which has a close fitting lid which can be bolted into place. All the joints of the box are sealed with clay, so that it will be practically air-tight. The box is kept in a furnace from twelve to fourteen hours, and a special effort is made to keep the furnace at an even temperature during that time, as any great fluctuation in the temperature has a tendency to make the material brittle. A temperature of 1,350 degrees F. is considered maximum. The cooling tub is provided with a water inlet at the bottom, and an overflow at the top, so that the water will be kept cool. All pieces such as links and quadrants should be let down into the water edgewise, to avoid springing them.

Mr. R. A. Mould, master blacksmith at the Omaha shops of the Union Pacific Railroad, made some comments on the subject which will be found of value and interest. Mr. Mould believes that the first thing to be considered in connection with case-hardening, is hardness; and the second, the condition of the material after the process of heating and cooling has taken place. The best results are not always obtained by hardening the pieces to the greatest possible depth. If a depth of 1/16 inch is sufficient to meet all requirements, nothing is gained by hardening to a greater depth. The length of time that it is necessary to keep the work in the furnace will depend upon the class of the work, and upon the depth required for the hardened part. The furnace should be so constructed that a uniform temperature can be maintained, and Mr. Mould believes that an underfeed oil furnace will give the best results, as the degree of heat can be more easily regulated.

* See article entitled "Spur Gear Planer" in the November, 1902, issue of MACHINERY.

THE MANUFACTURE OF SMALL STEAM TURBINES.

K. G. SMITH.*

K. G. Smith.†

Owing to the widespread interest in the steam turbine at the present time, the writer believes that a short article describing some of the constructive features of small sized turbines would be of interest to shopmen in general.

The Kerr steam turbine, in the manufacture of which the writer has been engaged for some time, is of the multi-stage nozzle-and-bucket type made in three sizes, ranging from 5 to 300 horse-power. The division into stages is made by cast iron partitions known as diaphragms into which are riveted the steam nozzles. The horse-power of any size of turbine is determined under a given set of conditions by the number and size of these nozzles. For this reason a turbine may be quickly changed to meet different or unexpected conditions. For example, in one turbine installation it was suddenly found necessary, after all plans were made, to run the unit non-condensing instead of condensing as originally intended, owing to the non-arrival of the condenser and the necessity of getting the plant started. A set of non-condensing nozzles was at once designed, and they were made and placed in the turbine in ten hours. The plant was then operated successfully and economically on a non-condensing basis.

Such flexibility of design necessarily entails careful thought on the part of the machine shop force to avoid an overwhelming number of jigs and special tools. Diaphragms, as shown in Fig. 4, are kept in stock ready for drilling at any time.

The jig shown in Fig. 2 will drill any required number of holes, and by changing the movable arm the drilling radius or size of hole may be varied. Two index plates like the one shown cover all the numbers of holes called for on all sizes of turbines.

To set the nozzles at the proper angle and give clearance on the buckets, a templet, Fig. 3, with a thin clearance shim is used. Once set against the templet, they are beaded in like boiler tubes with a special beading tool and pneumatic hammer. Before being set in the diaphragms, all nozzles must of course be reamed to the proper size and taper. This is done by special reamers held in the spindle of a high-speed sensitive drill, thus giving them a good clean finish on the interior surface. On the testing block all stage pressures are taken, and from the calculated pressures the accuracy of the reaming can be checked. Any marked variation from the proper pressure must be corrected. Such mistakes, however, seldom occur.

The most important parts of a turbine, so far as its running qualities are concerned, are the bearings and rotor. The

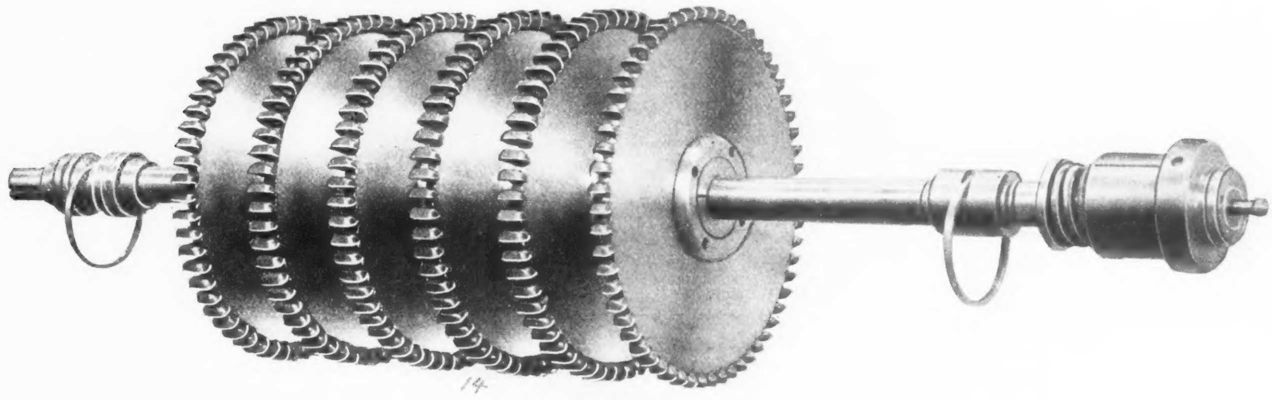


Fig. 1. Assembled Rotor of Kerr Steam Turbine.

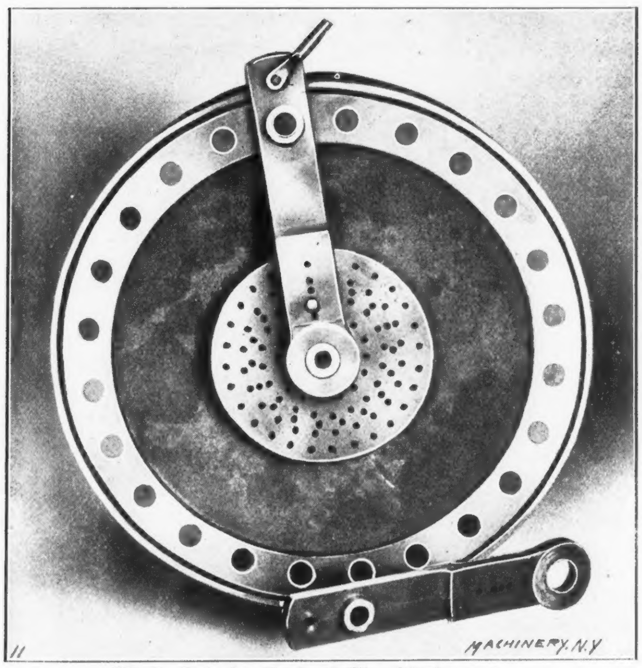


Fig. 2. Indexing Jig for Drilling Diaphragms.

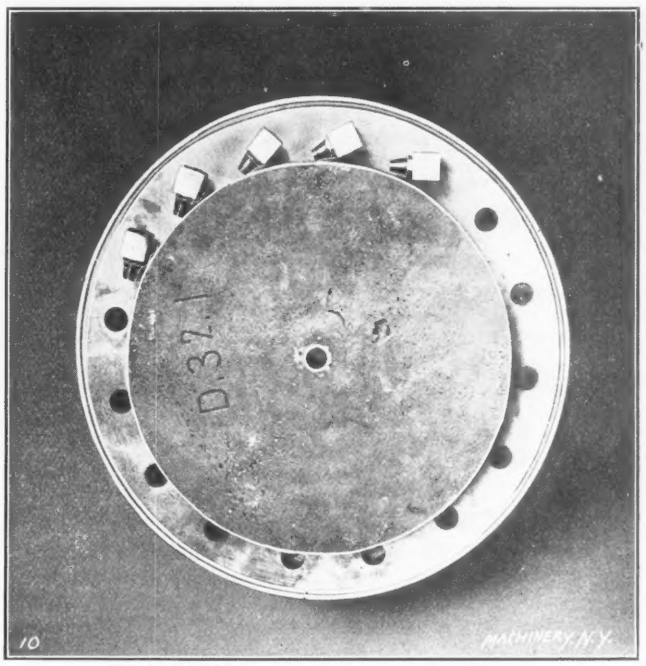


Fig. 3. Steam Nozzles set on Templet.

* Shop superintendent Kerr Steam Turbine Co., Wellsville, N. Y.

† Kenneth G. Smith was born in Dixon, Ill. He graduated from the mechanical engineering department of the University of Illinois, and served an apprenticeship with the Brown Corliss Engine Co., Corliss, Wis. He has worked for the Illinois Central R. R. Co., Westinghouse Machine Co., East Pittsburg, Pa., and the Kerr Steam Turbine Co., Wellsville, N. Y., having held the positions of assistant erecting engineer, erecting engineer, and shop superintendent.

bucket wheels, which form the main part of the rotor, Fig. 1, are of flange steel into which are set drop-forged steel buckets. The wheels are first dove-tailed in a slotting machine of special design operating like a gear cutter. The buckets are then riveted in under a heavy pneumatic riveter. So firmly are they fastened that the bucket itself will be destroyed before it can be pulled from the disk. By the use of properly formed dies the buckets are accurately aligned while being riveted.

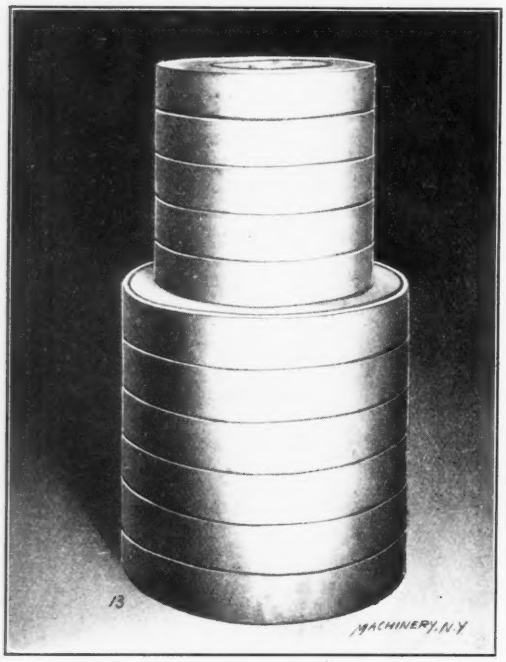


Fig. 4. Stock Diaphragms for Kerr Steam Turbines.

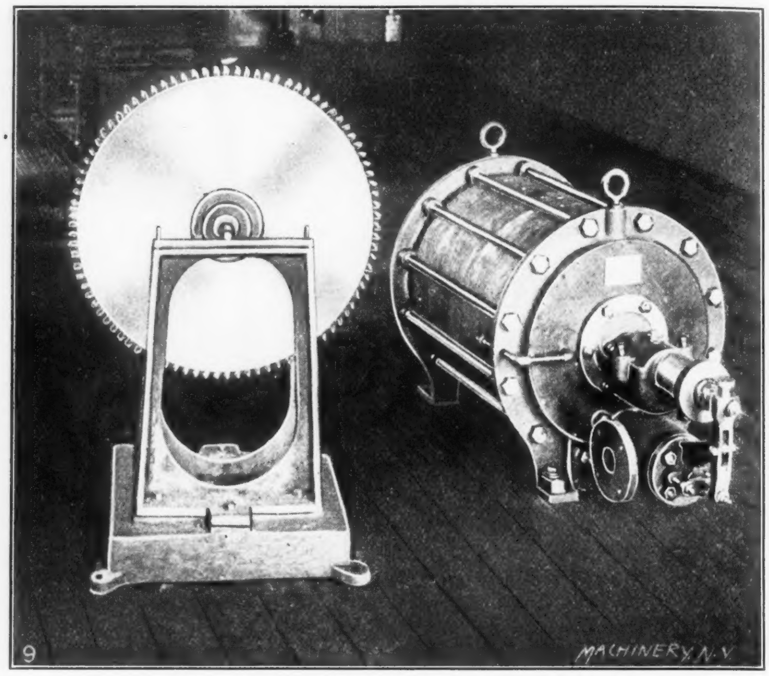


Fig. 5. Balancing Disk on Knife-edge Bearing Ways.

As is any high-speed machine, the balancing of the rotating parts is of paramount importance. For thin steel disks, like the bucket wheels, a static balance is sufficient when carefully and accurately made on a hardened mandrel rolling on hardened knife-edges. See Fig. 5. Each disk is balanced separately on its own hub, and any slight inaccuracies in individual disks tend to counterbalance each other when the whole rotor is revolving.

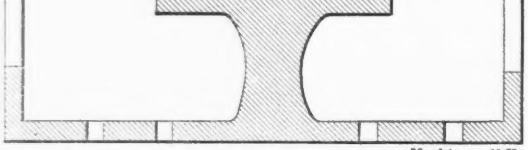


Fig. 6. Hollow Brake Pulley.

For shafts, nickel steel is used as giving the most satisfactory results. It stands heat best and is freest from internal strains. The shafts are first roughed out, and then all drilling and keywaying is done before the final cut is taken, thus insuring an absolutely true running shaft. With shaft sizes of $1\frac{1}{2}$ to $2\frac{1}{4}$ inches, the critical speeds are comparatively low, but as the turbines are never run at these speeds, the slight jar occurring when the critical speed is passed has no effect whatever.

The bearings are of bronze fitted with a special ring oiling device. For any bearing running at high speed the lubrication must be perfect; otherwise vibration will occur even if the bearing does not heat seriously. This is frequently the cause of intermittent spells of vibration in turbines and other high-speed machinery. Oil grooves large enough and numerous enough to carry a good supply of oil must be provided with the edges well chamfered, and care must be taken that the oil actually enters and circulates through the bearing so as to keep a continuous film surrounding the shaft. A well lubricated turbine bearing will last indefinitely, because, being direct connected, there is no belt pull and the bearing pressure is always light.

The testing of small turbines quickly developed a number of problems. When connected with fans, blowers, or pumps, at the shop, the unit, of course, can be tested as a whole, but for testing turbines alone a special form of Prony brake had to be devised.

For high speeds and high powers the ordinary form of brake cannot be used as it heats too rapidly, causing jarring and gripping of the brake pulley. The special form of hollow pulley shown in Fig. 6 has been found to give satisfactory results at speeds of 2,400 to 3,600 R.P.M., and for 10 to 300 horse-power. Water is delivered to the interior of the hollow pulley, and is thrown out through holes in the circumference by centrifugal force. The ordinary form of smooth, solid, externally lubricated pulley will carry as high as 40 to 50 horse-power at speeds up to 3,600 R.P.M. fairly well. In using a new brake for the first time it is a good plan to run it at a high speed, for a few seconds, with no water whatever. This burns off any high spots, and puts a glaze on the surface of the wood, causing it to bear smoothly on the pulley and to wear well.

One thing I would say in conclusion as to the manufacture of turbines and high-speed machinery in general. Faulty balance, faulty alignment, imperfect bearings and other faults of construction are evident as soon as the machine goes up to speed the first time. In other words, turbines will not run for a while and slowly develop troubles the germ of which was present at the beginning. Anything apt to cause trouble

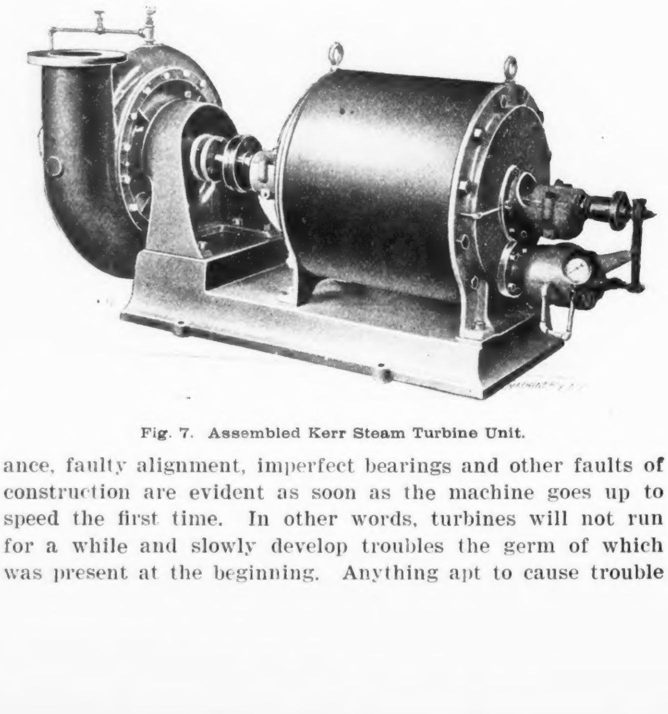


Fig. 7. Assembled Kerr Steam Turbine Unit.

will appear at once on the testing floor, where it can be remedied. A good turbine, once installed, is a thoroughly reliable and durable machine. In one foundry installation with which I am familiar, the turbine runs a fan for one hour and thirty minutes each day during the heat, requiring only the opening and closing of the throttle, and a pint of oil once a month.

* * *

BARR'S RULES FOR POWERING MACHINE TOOLS.

The following simple empirical rules compiled some time ago from the averages of many tests and observations by Mr. J. A. Barr, of the Westinghouse Electric & Mfg. Co., will be found useful in equipping machine tools with individual electric motors. The power ratings indicated for the conditions named agree, generally, with the average of shop requirements.

Lathes.—Engine lathes using one cutting tool of water-hardened steel at about 20 feet per minute:

$H. P. = 0.15\ S - 1.$

For heavy engine lathes such as forge lathes:

$H. P. = 0.234\ S - 2.$

In both engine and forge lathes S = swing of lathe, in inches.

Example: Find the power required to drive a forge lathe of 48-inch swing. Then $(0.234 \times 48) - 2 = 9.23$ H. P.

Boring Mills.—For the operation of standard boring mills, using one cutting tool of water-hardened steel at approximately 20 feet per minute, the following formula will be found to represent good practice for heavy work:

$H. P. = 0.25\ S - 4$, wherein S = swing of mill, in inches.

Milling Machines.—For normal milling machines, using water-hardened steel cutters running at about 20 feet per minute, the following formula will be found useful:

$H. P. = 0.3\ W$, wherein W = distance between housings, in inches.

Drill Presses.—For normal drill presses, using water-hardened steel drills, running at a peripheral cutting speed of approximately 20 feet per minute the following formulas apply:

$H. P. = 0.06\ S.$

For heavy radial drill presses:

$H. P. = 0.1\ S,$

wherein S = swing, in inches.

Slotters.—Normal crank slotters, using water-hardened steels at cutting speeds of from 15 to 26 feet per minute, require:

Stroke.	Horse-power.
10 inches.	5
18 "	7
30 "	10

Shapers.—Shapers using water-hardened tool steels at cutting speeds of from 15 to 20 feet per minute have the following power requirements:

Stroke.	Horse-power.	Stroke.	Horse-power.
16 inches.	3	24 inches.	5
18 inches.	3½	36 inches.	6½

Planers.—For normal planers using water-hardened steel at cutting speeds of from 15 to 20 feet per minute, the power is approximately as follows:

$H. P. = 3\ W.$

where W = width between housings, in feet.

For heavy forge planers:

$H. P. = 4.92\ W.$

By normal planer is meant a planer in which the length of the bed in feet is approximately two-tenths the width between the housings in inches. For example, a 48-inch planer would have a length of platen of approximately 9.6, or 10 feet.

The above formulas are for planers having a ratio of cutting to return speeds of approximately 1 to 3, and cover planers with two tools in operation. If more than two tools are used, or if the ratio between the forward and return speeds is more than 1 to 3, the horse-power given by above formula should be increased. It should be noted that where the length of bed is greater than that mentioned above the horse-power should be increased.

THE TRIBULATIONS OF AN INVENTOR.

JOHN.

A long, long time ago, when the Teddy bears roamed wild in the cities, and the rushing red devil wagons tore up and down throughout the land, there was a noted country on our planet called Yewessay. In this country, besides the high financiers, railroad presidents, and captains of industry, there was a very large number of common, ordinary people like ourselves, though one could never have guessed it from the newspapers. Among these common, ordinary people there lived quite a number of peculiar people, who mostly belonged to either one of two classes. The brains of these people were abnormally developed, or, perhaps, abnormally undeveloped; their temperament was such that they could not let well enough alone. In one class the abnormity appeared as de-structiveness. These were called lunatics. When a lunatic saw something which did not suit him, he immediately smashed it, or tried to. In the other class, the abnormity appears as con-structiveness. These were termed inventors. When an inventor saw something which did not suit him, he immediately invented something better, or tried to.

The lunatics were treated kindly and provided with food, shelter, and raiment by the government, but, though the inventors were often, yea, generally, without money, and all other modern conveniences, the government never even appointed a commission to investigate them, let alone doing anything substantial.

The great aim of every inventor, at that time, was to obtain a patent. A patent was really merely a document setting forth that, whereas the inventor had petitioned the Commissioner of Patents for a patent for an alleged new and useful improvement, and had complied with the various requirements of the law in such cases made and provided, and etc., etc., that the inventor, his heirs, or assigns should have the exclusive right to make, use, and vend the said invention throughout the land of Yewessay and the territories thereof for the term of seventeen years.

These patents were held in great reverence and awe by the poor inventors, and were believed (at least by those who never had obtained one) to be of great value—a sort of Midas' touch by which everything could be turned into gold. As a matter of fact, the patents were generally worth very little, and had it not been for the active advertising campaign carried on by certain interested parties, the inventors would soon have realized the true state of things, and the number of patents applied for each year would have been less by a great many thousand. There was a great host of patent attorneys who grew fat on the fees they obtained from the inventors for preparing their applications for patents, and the country was flooded with little books published by these men telling of how inventor Jones had made a million out of his patent everlasting steel-pointed lead pencil, how inventor Smith had made three millions on his patent airless pneumatic tire, and of how sixteen billion dollars had been offered for a cheap substitute for water, and twenty-three cents for a new car coupler.

After reading a few hundred of these little works of art (and craft), the inventor usually began to long for some of the golden dollars dangled so temptingly before his eyes, and, as it is the easiest thing in the world for an inventor to invent, the fees were soon in the hands of the attorneys, which you must admit is quite the proper place for them to be, seeing that they went to so much trouble to secure them. It seems a peculiar oversight, as we look at it now, that none of the little books drew attention to the fact that, while about fifty thousand patents were granted every year, about forty thousand did not profit the inventor at all, and, of the remaining ten thousand, but a very small proportion realized any substantial sum. Perhaps the publication of this information might have discouraged some of the inventors, and as that is the last thing any of the attorneys ever wanted to do, may be the information was accidently omitted for that reason.

Well, this little fairy story is about an inventor that lived in those good old times, in the remarkable land of Yewessay. This inventor, like most others of his kind, was poor, but he had a great idea. Every inventor in those days had a great

idea. This was the principal symptom of the malady, and, though it really did no good to treat the patient, as the malady was practically incurable, it was, then, considered good practice, since hydrotherapy had become the fashion, to use the cold water treatment. Liberal quantities of H_2O, temperature 32½ degrees F., were applied to the great idea whenever convenient, and the wet blanket pack was frequently used. No one was ever permanently benefited by this method, though the treatment was a source of much discomfort to the patient.

But to resume, the great idea of this inventor was a method of making water run up hill. This idea was the result of much study, and much burning of the midnight gas (to the great disgust of the landlady). It was evident to all that if the inventor's claims proved true, he had indeed made a great and valuable invention, but, strange to relate, though all the friends of the inventor congratulated him on the making of such an excellent invention, not one of them would invest one single shekel to help build an experimental machine. The inventor was thus forced to go among strangers seeking the mighty dollar to develop his idea.

Many were the men he visited, and many were the opinions he received, also much experience, but no money, and the inventor was almost discouraged. At last he fell into the hands of the brokers. These, after hearing the inventor's description of his wonderful invention, said: "We must have expert advise upon this."

And many were the experts they visited, and many were the opinions they received (all different), and much advice how not to do it, but no money, and the inventor came to the conclusion that he knew more about his own invention than any of the wise experts could tell him. So also thought the brokers. Then said the brokers, "We must have the patent records searched."

And many were the attorneys they visited, and many were the flattering opinions they received, and many were the searches the attorneys made, but not one anticipating patent did they find, nor any device even remotely related to the invention.

Then said the brokers: "This is very much of a speculation, a gambler's chance; we must have a large commission for telling our friends that this is a sure, get-rick-quick, 520 per cent a year, and no-chance-of-loss investment. You must assign 66 2/3 per cent of your invention to us, and we will then find you the $713.30 you require to build your machine." (This is an exceedingly compact, abridged, and expurgated edition. A verbatim report was recorded on 33 miles of steel wire by the telegraphone, and may be found in exhibit K331,107 court records.)

The inventor was then kept busy for a long time signing assignments, sealing seals, transferring transfers, and performing other little acts necessary in the premises, not otherwise more particularly mentioned or described.

Having secured the money, the inventor then started to build his machine. In a few months it was completed, but alas! when tried it would not only not make the water run up hill, but it would not keep it from running down (and the wise experts looked very wise and smiled behind their hands). The poor inventor scarcely knew what to do. He was sure the principles were all right, but—there was the machine. For forty days and forty nights he labored over it, and at last, by changing one little thing here, and another little thing there, he managed to fix the machine so that it would at least keep the water from running down hill, and that was quite an achievement, you must admit (but the wise experts looked very wise and smiled behind their hands).

About this time the inventor had spent all of the $713.30 supplied by the brokers, and $23 besides, and what he owed made a bit beside that, and he had only one shirt and no credit, so you see he was, technically speaking, pretty hard up. At last the inventor went to the brokers again, and after talking and talking and talking (he was a good talker) again and again, he obtained $479.17 more. This was the exact amount required to finish the invention. The inventor knew that this was the right amount because he had carefully figured it out.

Well, to shorten this long story, after many moons of tedious, heart-breaking work the machine was made to run successfully, the water ran up hill (the wise experts stopped looking very wise and looked foolish instead), and the inventor bought himself a new suit of real store clothes (on credit).

During the time the invention was being perfected, the inventor, who, by the way, was a deacon in the Methodist Church, had learned a new language, which was then extensively used in intimate conversation with unruly and obstreperous, animate or inanimate objects. It was generally written, at least in print, in dots and dashes, much after the fashion of the Morse code, thus, "Oh ——— ——— the ——· ——— — — to — ——— ——— what in ——— is the next thing to go wrong?" To the ordinary man this will, of course, be unintelligible, but here and there throughout the land, there will be found men who have passed through the deep seas of mechanical trouble, and of necessity learned the language, and also a few individuals to whom is given the power to speak this language in moments of supreme exaltation. These will understand the writing.

The machine having proved successful, it was necessary that a patent should be obtained. Now, the preparing of a patent application was supposed to be a most abstruse and difficult art, only to be discovered after many years of apprenticeship and much study (afterward the inventor changed his mind about this), so certain skilled attorneys were employed to make out the application and prepare drawings of the machine.

Now that the inventor was really going to have a patent of his own, he began to read up a little on the subject. He found that the exclusive right to make, use, and sell his own invention, for a limited time, was given him only in exchange for a full and complete description, so that others might work the invention when the patent expired, that the patent cost the government nothing, that there was no guarantee went with the patent, and that a patent was not generally considered of any great value until it had been confirmed by the courts.

The application was soon prepared, duplicated, triplicated, sworn, witnessed, signed, sealed and delivered, bound hand and foot to the Philistines, or rather, to the patent office, and,

"There it lay, there it lay,
'Til it began to rot."

After the aging process was sufficiently completed, the office took action, the application was rejected, the device claimed having been shown in patents to—

T. Edinghouse: 1719—Improved silent phonograph.

G. Westingson: 1760—Double duplex hair breaker.

B. Brown: 1492—Machine for removing tails from Teddy bears.

The inventor was dumbfounded. The patents to these men showed nothing remotely connected with his inventions, but, ah! there was a slight similarity in the pictures. That must be the reason. A long letter was written to the examiners, carefully pointing out that the devices were entirely different, and that it was hoped that the patent would soon be allowed.

After another long interval (so long that the inventor had to have his hair cut three times, and you know how long inventors wear their hair when times are hard) another action came; the first references were dropped; application rejected on patents to—

Charles Parsconi: 1711—Improved steam windmill.

G. Marsons: 1769—New barb-wireless telephonograph.

The inventor was dumbfounded again, for this time there was no similarity even in the pictures. Perhaps the examiner was confused by the mention of water in all of the specifications.

The attorneys wrote another long letter, carefully explaining that the inventions cited had no bearing on the case, and then the inventor started in to set out some century plant cuttings so that he might raise a little money selling blossoms, and so keep body and soul together while the patent office was getting ready to issue the patent.

The patent office in those days published a paper each week, and in it, besides a list of patents granted, etc., was given a statement of how many weeks, months, years, or centuries, each department was behind in its work. The inventor used to make great calculations from this report. The action would be due, say, Friday, the 13th; allow three days in the

mail, that would be Monday, say Wednesday for sure; and then the poor old inventor would hang around the post office, day after day, week after week, month after month, waiting for that action. By and by it would come, another damned, discouraging, heart-breaking rejection on some trivial point of resemblance to some ancient unworkable device that happened to present itself to some incompetent examiner.

And in those days there was famine in the land.

After some more valuable time had been lost, the patent office suddenly discovered that the application covered too much ground—it must be divided. A few months more lost, more fees, more signing, more sealing, more waiting, more damning.

But the inventor found that the office had only been playing with the case so far, now it was getting down to real business; the next citations made it necessary to cut off some of the less important claims. The attorneys amended the application to avoid conflict with the references, and advised the office that the case was now in condition for allowance. But was it? Guess again.

Some more months delay, some more references, 'nother letter, some more months, more references. It reminded one of the Kansas farmer story, "More hogs, more land, more corn, more hogs, etc.," but in this case it was more references, and the inventor was getting poorer all the time.

The inventor gradually found out a good many things about the patent office. He found that the space occupied by the office was entirely too small for the work to be done, that there were not enough examiners, and that not all those in the office were competent to fill their positions. But the most surprising fact, in view of the state of things in the office, was that it had a surplus of several million dollars which it had collected from the inventors of the country and for which it had given them no return. The inventor thought that the government of his great and glorious country would at least have made some effort to give the inventors a square deal and a quick deal, when they put up all the money, but he was only one of those idealists who believe that the government is of the people, for the people, and by the people.

About the time the inventor's youngest great-grandchild was getting married, the patent office allowed the claims then standing, and, after extracting another fee from the inventor, issued the patent. Fortunately, there was still left to the inventor, after the continual hacking and chopping of the patent office, some really good claims that would protect the invention from those who would try to copy it, else the fate of the inventor had been sad indeed.

How the inventor got along with his patent after he got it, is, as my esteemed contemporary says, another story.

* * *

CORRECTING PERSPECTIVE IN SHOP PHOTOGRAPHY.*

S. S. NEW.†

As stated by Mr. Dow, in his article on Shop Photography, in the December issue of MACHINERY, a long focus lens should be used wherever possible when photographing machinery, a wide angle lens being sure to produce distortion. There are cases, however, where, owing to the lack of space or great breadth of the subject photographed, it is imperative that a wide angle lens be used. When this is necessary, it is often possible to correct the distortion, particularly when the subject consists of several parts.

A case of this kind is illustrated by the accompanying cuts, representing a gas-engine-driven Crocker-Wheeler alternator with direct connected exciter. Owing to the small space available at the time the photograph was taken, it was necessary to use a wide angle lens to include the entire set. This, however, produced a negative as shown in Fig. 1, in which the exciter, owing to its nearness to the camera, appears as large as the generator. To reduce this with all important details by retouching would have been very expensive. A print of the photograph was put in front of the camera at a distance such that the image of the exciter on the ground glass was of such a size that it appeared in its true proportion, and a negative was made. The exciter was cut out of a print from this reduced negative and pasted over the abnormal exciter on the original print. The artist then had only to paint in the brick work, windows, etc., around the edges of the exciter and shorten the supporting brackets.

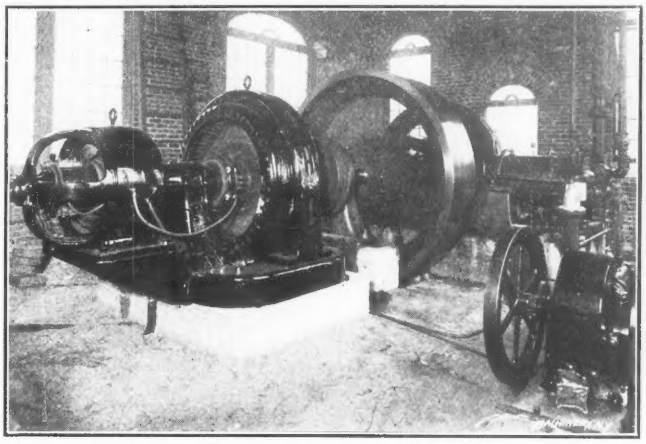


Fig. 1. Photograph taken with Wide Angle Lens showing the Objects to the Left in Exaggerated Proportions.

This method is often used in "faking" photographs, but this example is given as a case where "faking" was necessary to correct the "faking" of the wide angle lens. The retouched photograph is thus more accurate than the original print.

* For previous articles on shop photography, see "Shop Photography," December, 1907, and other articles there referred to.
† Address: Crocker-Wheeler Co., Ampere, N. J.

* * *

The cable companies, anxious to maintain their monopoly on the sending of messages between the new and the old world, have made the statement that they can send a message from the London Stock Exchange to the New York Stock Exchange, and receive a reply, in four minutes. These messages, however, are usually very short, and under such circumstances it makes very little difference whether the message itself is transmitted at the rate of 50 words a minute or 25 words a minute. The records are, of course, obtained by arranging everything beforehand, so that no obstacles have to be overcome, working the line direct between London and New York without any delays at all over the land lines. It is most likely that if similar arrangements were made in connection with the wireless stations, it would be possible to achieve similar results by wireless telegraphy, and ultimately, no doubt, the speed of working wireless telegraphy will be greater than that at present possible for cables, or, at least, fully as great. It seems unreasonable to condemn the wireless system because it has not sprung forth perfect from the start. It has, in fact, developed much quicker than the telegraph, and there are reasons to believe that its future development will be accelerated even in a greater proportion.

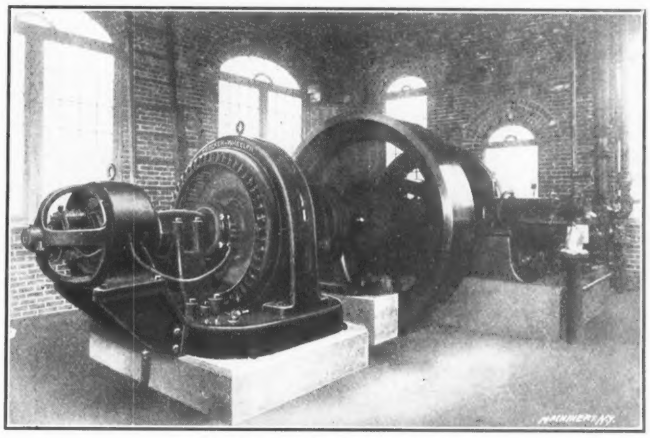


Fig. 2. Corrected Photograph.

* * *

A REMARKABLE MACHINE TOOL!

ONE 14 inch Sebastian gas engine lathe, good as new, cheap to quick buyer. Apply 1630 Park av., near 14th st., Hoboken.

—*The Evening Telegram* (New York).

STANDARD DRAWING-ROOM METHODS.*

M. R. KAVANAGH †

M. R. Kavanagh.‡

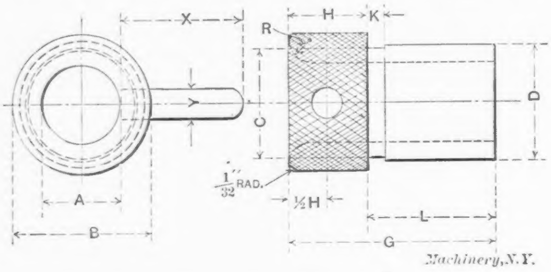
The theme of the standardization of methods in the drawing-room is one which is of vital interest to a large number of the readers of MACHINERY, who are connected more or less directly with this line of work. There are so many leaks possible in the drafting department of any firm, so many ways in which time may be saved by having a way to do things and a place to put them, that a few words upon this topic cannot fail to interest many.

Of course, good light and the least possible amount of noise and confusion in the room during working hours are a foregone conclusion, while the equipment and size of the quarters devoted to this branch of the business must necessarily depend upon the size of the company. Beyond this, however, the way in which the drawing-room ministers to the wants of the factory, and the accuracy and speed with which the drawings are turned out, depend greatly upon the efficiency of the system and the longheadedness of the chief.

About the first step in any good system is the adoption of a number of general rules, governing the production of any new work, which may be easily blue-printed and handed to any new man on his arrival, thus giving him a line on the general way in which the work is desired to be gotten out. These data may conveniently cover such points as sizes of drawings, methods of dimensioning, limits to be used on the work, methods of indicating various finishes, styles of lettering, cross sections, etc. We have gone a good deal further than this in the drafting-room where the writer is employed, and have what we term our data sheets. These, in addition to the above, comprise a list of the stock of steel in the various sizes, shapes, and qualities, carried by the firm; stock patterns, examples and explanations of the various formulas in use in the shop; and, in general, a collection of data relative to our work, which the draftsman or designer might spend much valuable time in looking up. Each man is furnished with a copy of these data sheets, and he retains them while in our employ. That they are appreciated and valued by the men is evident from the tenacity with which they hold on to their copies. This system is by no means original with our firm, being in use in a number of the large firms throughout the country, such as the Westinghouse Co., the General Electric Co., the Brown & Sharpe Mfg. Co., and many others.

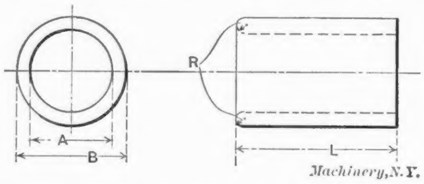
It is a fact, deplorable though it may be, that a large number of our American draftsmen are not really capable of sitting on the job. It is seldom that we find a man who combines with accuracy and expedition the knowledge of shop methods and practice which would make impossible some of the rather amusing "bulls" we find from day to day. It is on this account, as well as on account of the fact that everyone, no matter how careful, will occasionally go wrong, that an efficient checking method is essential to good work. We all know how glad the shopman is to find a mistake made by the drawing-room, and how quickly he will come back on the draftsman if he does find one. Mistakes, too, are always costly, and the fewer there are, the more valuable the drafting room is to the business. The method we follow is this: The chief explains to the draftsman, by sketch or verbally,

TABLE I. REMOVABLE BUSHINGS FOR TAPPED HOLES.



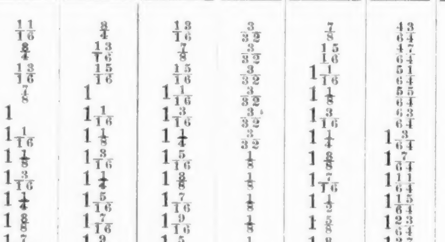
Tap Size.	Thds.	A	D	L	B	H	C	K	G	X	Y	R
3/16	24	No. 26	5/16	1/2	1/2	1/2	19/64	3/32	1	11/16	3/16	1/16
1/4	20	13/64	3/8	9/16	9/16	1/2	23/64	3/32	1 1/16	11/16	3/16	3/32
5/16	18	1/4	7/16	5/8	5/8	5/8	27/64	1/8	1 1/4	3/4	3/16	3/32
3/8	16	19/64	1/2	11/16	11/16	5/8	31/64	1/8	1 5/16	3/4	3/16	1/8
7/16	14	23/64	9/16	13/16	13/16	5/8	35/64	1/8	1 7/16	3/4	3/16	1/8
1/2	12	13/32	5/8	7/8	7/8	5/8	39/64	1/8	1 1/2	3/4	3/16	1/8
9/16	12	15/32	11/16	15/16	15/16	5/8	43/64	1/8	1 9/16	3/4	7/32	1/8
5/8	11	33/64	13/16	1 1/16	1 1/16	5/8	51/64	1/8	1 11/16	15/16	7/32	1/8
3/4	10	5/8	15/16	1 3/16	1 3/16	3/4	59/64	1/8	1 15/16	15/16	1/4	5/32
7/8	9	3/4	1 1/16	1 5/16	1 5/16	3/4	1 3/64	3/16	2 1/16	15/16	1/4	5/32
1	8	55/64	1 3/16	1 1/2	1 1/2	3/4	1 11/64	3/16	2 1/4	1	1/4	5/32

TABLE II. STANDARD PERMANENT BUSHINGS—PLAIN.



A	B	L	R	A	B	L	R
1/16	1/4	1/2	1/16	9/16	7/8	1 1/8	1/8
1/8	5/16	9/16	1/16	5/8	1	1 3/16	5/32
3/16	7/16	5/8	3/32	11/16	1 1/16	1 1/4	5/32
1/4	1/2	3/4	3/32	3/4	1 1/8	1 3/8	5/32
5/16	9/16	15/16	3/32	13/16	1 3/16	1 7/16	5/32
3/8	11/16	7/8	1/8	7/8	1 1/4	1 1/2	5/32
7/16	3/4	15/16	1/8	15/16	1 3/8	1 5/8	3/16
1/2	13/16	1 1/16	1/8	1	1 7/16	1 3/4	3/16

TABLE III. STANDARD PERMANENT BUSHINGS—SHOULDER.



A	D	F	B	E	G	C	H	R
3/8	11/16	3/4	13/16	3/32	7/8	43/64	1/8	1/8
7/16	3/4	13/16	7/8	3/32	15/16	47/64	1/8	1/8
1/2	13/16	15/16	15/16	3/32	1 1/16	51/64	1/8	1/8
9/16	7/8	1	1 1/16	3/32	1 1/8	55/64	1/8	1/8
5/8	1	1 1/16	1 3/16	3/32	1 3/16	63/64	1/8	5/32
11/16	1 1/16	1 1/8	1 1/4	3/32	1 1/4	1 3/64	1/8	5/32
3/4	1 1/8	1 3/16	1 5/16	1/8	1 3/8	1 7/64	3/16	5/32
13/16	1 3/16	1 1/4	1 3/8	1/8	1 7/16	1 11/64	3/16	5/32
7/8	1 1/4	1 5/16	1 7/16	1/8	1 1/2	1 15/64	3/16	5/32
15/16	1 3/8	1 7/16	1 9/16	1/8	1 5/8	1 23/64	3/16	3/16
1	1 7/16	1 9/16	1 5/8	1/8	1 3/4	1 27/64	3/16	3/16
1 1/16	1 9/16	1 5/8	1 3/4	1/8	1 13/16	1 35/64	3/16	7/32
1 1/8	1 5/8	1 11/16	1 13/16	1/8	1 7/8	1 39/64	3/16	7/32
1 1/4	1 3/4	1 13/16	1 15/16	1/8	2	1 47/64	3/16	7/32

* The following articles on drafting-room practice and kindred subjects have previously been published in MACHINERY: Drafting-room Practice, October, 1894; Drawings for the Shop, September, 1895; System in the Drafting-room, November, 1896; Modern Drafting-room Supplement, March, 1897; A Model Drafting-room, January, 1900; Drafting Office Photography, April, 1901; Working Drawings, October and November, 1901; Mechanical Drawing and the Shop, September, 1903, engineering edition; Drafting-room Practice, March, 1905; Drafting-room of the B. F. Sturtevant Co., September, 1905, engineering edition; Instructions for Draftsmen, and Drafting-room Practice, September, 1905; Tracing, Lettering, and Mounting, September, October and November, 1906; The Card Index in the Jobbing Shop, June, 1907, and also previous articles referred to in that issue.

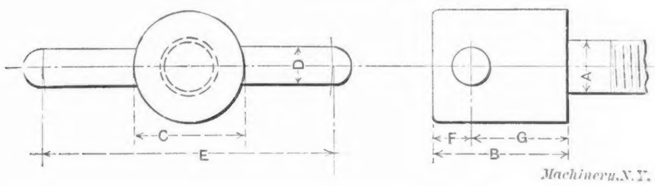
† Address: 22 Bethune Ave., East, Detroit, Mich.

‡ M. R. Kavanagh was born in Chicago, Ill., 1882. After being graduated from the high school, he took courses in mechanical, electrical, and bridge engineering, in the American and the International Schools of Correspondence. He has been connected with the C. B. & Q. and Lake Shore Railroads; Burroughs Adding Machine Co., Detroit; Cadillac Automobile Co., Detroit; and has had charge of office, drafting-room, and cost department for National Mfg. Co. Mr. Kavanagh is now with the Ford Motor Co., Detroit, in the capacity of tool designer. His specialty is designing tools for interchangeable manufacturing.

what he desires, and the drawing is made under the supervision of the chief who gives it his approval as regards design. It is then submitted to a committee consisting of the chief engineer, his assistant, and the two head designers. They either approve it or order such changes as they think advisable, and the drawing is returned to the draftsman for alteration, if necessary, or, if not, is passed to the checker, a competent man who does nothing but check the drawings. The drawing is then thoroughly checked by him for accuracy as to scale, dimensions, and mathematical calculations, as well as for its compliance with our system. If any corrections are found necessary, the drawing is again returned to the draftsman, who makes the necessary alterations and returns it to the checker, receiving his approval on same. The drawing then goes to the tracer, who makes the tracing and returns the original and the tracing to the checker. If any corrections are necessary on the tracing, the tracer makes them under direction from the checker, who finally approves the tracing. It is then ready for the blue-print room, and any errors which show up later are held against the checker. This system is very thorough and the errors that occur are few and far between.

Another feature of value, is the grouping of the various blue-prints covering the manufacture of a certain machine, or a number of machines of similar character, in bound packs or books, located at various points throughout the plant. This

TABLE IV. CLAMPING SCREWS.



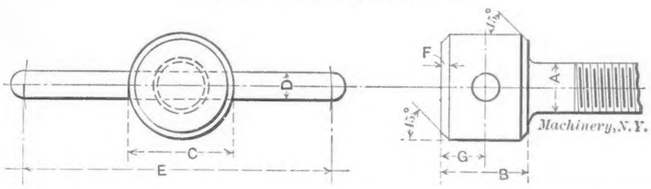
A	B	C	D	E	F	G	Threads.
5/16	7/8	5/8	1/4	2 1/4	5/16	9/16	18
3/8	15/16	11/16	1/4	2 1/4	5/16	5/8	16
7/16	1	3/4	1/4	2 1/2	5/16	11/16	14
1/2	1 1/16	7/8	1/4	2 3/4	5/16	3/4	12
5/8	1 1/4	1 1/16	5/16	3	3/8	7/8	11
3/4	1 3/8	1 1/4	5/16	3 1/2	3/8	1	10

obviates the continual replacement of lost prints, which consumes so much time where loose prints are used. Each book is receipted for by the foreman who has the work covered by it in charge, as are also the new prints made necessary by changes in design or dimensions. A record of the location of these books is, of course, kept in the drawing-room, and a man is detailed to keep them up to date. There is an exception to this rule in the screw machine department, as the prints of the parts are here mounted on boards and shellaced, the operator having one of these cardboard mounts on his machine where he can refer to it. The mounts not in use are kept in a cabinet for that purpose, where they are easily accessible to the foreman of the department in planning his work. In this connection it might be well to note that all the prints necessary to go into any one department are those referring to operations performed in that particular part of the works, and the drawing-room is generally the only place where a complete set of prints is available.

For some time a good system of handling and recording the changes in the various parts bothered us, but the system we are now using seems to fill the bill very well. If the change is a slight one, as for instance the change of a dimension, the tracing is changed, the date of change being noted in the lower right-hand corner, and the various prints are changed by the man in charge of that work. If the design is changed, a new tracing is made, the old one marked obsolete, new prints made and put in the books, and the new tracing filed with the old one. In each case a record of every change is made by the clerk in a book kept for that purpose, and as the parts are all arranged numerically it is very easy to refer to this record to find the details of the change in making repairs or filling order for old parts.

It is remarkable what a number of drawings will accumulate in the course of a few years, where old designs are being constantly brought up to date, and new machines being added to keep abreast of the times. Owing to this fact, we found it necessary to design and have built a number of cabinets, with drawers made to fit the different sizes of drawings. In these drawers the tracings are filed, as has been said, according to numerical order. We have also installed, and find it a great help, a card index giving the exact location and size of the drawing of the particular part sought, and in case the number of the part is not known, a cross index gives an alphabetical classification. As an auxiliary to this index we have a smaller one in which are grouped such tools as bits, reamers, special drills, counterbores, etc., which we find to be a great aid and convenience to the designers in making up similar tools, or, as often happens, in adapting the old tool to a new part. This leads on to the statement that in our drawing-room, as in many others that I know of, there are two distinct divisions, one for the design and production of the drawings covering the machines themselves, and one for the design of the tools necessary for the economic production of these parts. In the former department the data utilized can for the greater part be found in the standard mechanical works or the trade catalogues. In the tool designing department, however, we have a number of standards of which a few examples are here given, compiled mostly from the book of experience, of which, so far as I have been able to learn, there is no authentic edition.

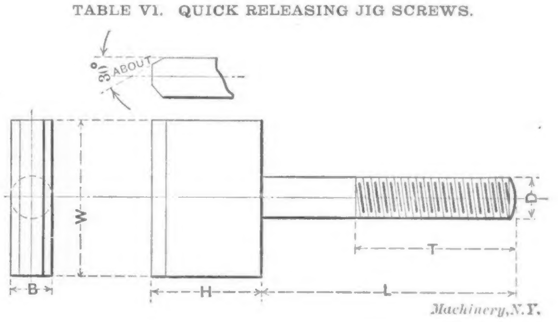
TABLE V. CLAMPING SCREWS.



A	B	C	D	E	F	Threads.	G
5/16	5/8	5/8	3/16	2 1/4	1/16	18	5/16
3/8	5/8	11/16	1/4	2 1/4	1/16	16	5/16
7/16	5/8	3/4	1/4	2 1/2	1/16	14	5/16
1/2	5/8	7/8	1/4	2 3/4	1/16	12	5/16
5/8	3/4	1 1/16	5/16	3	3/32	11	3/8
3/4	3/4	1 1/4	5/16	3 1/2	3/32	10	3/8

Tables I, II and III give data covering the more common type of drill jig bushings. These bushings may, with the

TABLE VI. QUICK RELEASING JIG SCREWS.



D	Threads.	L	T	W	H	B
5/16	18	1 1/2	1	1 1/8	3/4	5/16
3/8	16	1 5/8	1 1/8	1 1/4	3/4	3/8
7/16	14	1 5/8	1 1/8	1 3/8	7/8	7/16
1/2	12	1 3/4	1 1/4	1 1/2	7/8	1/2

proper allowance for finish and lapping, be made up in quantities in the screw machine department, and sent to the toolroom for use when required. The material used in making bushings varies in different shops, and although some designers claim that tool steel is the best for this purpose, I have seen both tool steel and soft machine steel used with equal success, the latter of course being case-hardened. To prevent the movable bushing from turning with the drill, we use a simple knee pin placed as near as possible to the outside

diameter of the bushing, and just fitting over the pin shown in the bushing itself. This provides an efficient stop and allows the bushing to be turned nearly completely around in removing. The knurled portions of the bushings are also made ample, to allow of their being easily grasped by the operator.

Table IV gives dimensions of clamping screws used on fixtures where the head of the screw binds directly onto the strap or clamp. It is sometimes advisable to make the stud

TABLE VII. WING NUTS.

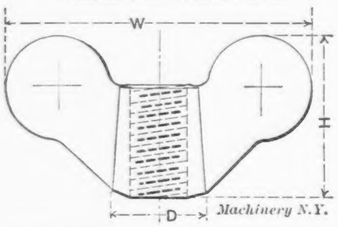
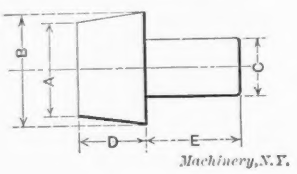


TABLE VIII. INSERTED FEET FOR JIGS.



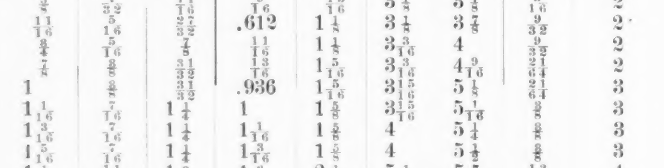
Diam of Bolt.	Thds per inch.*	D	H	W	C	A	B	D	E
1/4	20	7/16	5/8	1 3/16	1/4	3/8	7/16	5/16	7/16
5/16	18	1/2	3/4	1 7/16	5/16	1/2	9/16	3/8	1/2
3/8	16	17/32	7/8	1 3/4	3/8	9/16	5/8	3/8	9/16
1/2	12	3/4	1 1/4	2 3/8	7/16	5/8	11/16	3/8	11/16
					1/2	11/16	3/4	1/2	3/4

* This column dependent on shop standard.

permanent in the body of the tool, and use a nut with a handle through it similar to the head of the screw here shown. Table V gives data for another form of clamping screw. In this case, however, the screw works through a plate or cover and clamps directly onto the work. These clamping screws are made of machine steel, case-hardened, and the handles, of cold rolled stock, are pressed into them.

In Table VI dimensions are given for a form of jig screw used for clamping the cover or bushing plate on a jig, the plate being so slotted that a turn of the screw will bring the head in such a position that the cover may be thrown back, releasing the work quickly. This is often used on fixtures

TABLE IX. FOUR-LIPPED COUNTERBORES.



A	B	C	D	E	F	G	H	No. Morse Taper Shank.
9/16	7/32	21/32	1/2	25/32	2 3/4	3 3/4	3/16	1
5/8	7/32	11/16	9/16	13/16	3 1/8	3 7/8	3/16	2
11/16	5/16	27/32	.612	1 1/8	3 1/8	3 7/8	9/32	2
3/4	5/16	7/8	11/16	1 1/8	3 3/16	4	9/32	2
7/8	3/8	31/32	13/16	1 5/16	3 3/16	4 9/16	21/64	2
1	3/8	31/32	.936	1 5/16	3 15/16	5 1/8	21/64	3
1 1/16	7/16	1 1/4	1	1 5/8	3 15/16	5 1/16	3/8	3
1 3/16	7/16	1 1/4	1 1/16	1 5/8	4	5 1/4	3/8	3
1 5/16	7/16	1 1/4	1 3/16	1 5/8	4	5 1/2	3/8	3
1 1/2	11/16	1 3/4	1 3/8	2 1/4	5 1/8	5 7/8	13/32	4
1 3/4	11/16	1 3/4	1 9/16	2 1/4	5 3/16	6 5/16	13/32	4
1 15/16	29/32	2	1 3/4	2 7/16	5 1/4	6 1/2	13/32	4

where a slight pressure is all that is needed, and a quick release of the work is essential to rapid operation. These screws are made of machine steel and case-hardened.

Table VII gives the general dimensions of the standard wing nut, and is merely for convenience in laying out. Table VIII gives data for the inserted feet we use in our cast iron jigs. These feet are made of machine steel, case-hardened, and are a press fit in the jig. Finally, Table IX gives dimensions of counterbores that we use in the works, and is exceedingly handy in working out counterboring fixtures for the various parts, and in proportioning the removable and permanent bushings in jigs where it is desired to drill and counterbore without removing the work.

There are a number of other tables of data, but as they are too highly specialized to be of general interest they will not be given here. There is a point in connection with the design of special screws for the different parts that merits mention. All screws of special shape are designed with the slot in the head having a certain relation to the diameter of the threaded portion. This prevents much of the trouble generally experienced in the assembling department due to screws being screwed in with such force as to break off the head, when the head is large and the body diameter small.

* * *

THE CONVENIENCE OF FORMULAS.

One of the difficulties of editing MACHINERY is the presentation of engineering matter necessarily requiring mathematical formulas in a way that will not be objectionable to the readers who have not acquired a certain amount of technical education. A few articles on design, no doubt, are beyond the comprehension of some readers, but if such readers could realize that much of the stuff that they call algebra is nothing more than a shorthand method of expressing very simple ideas, it would be very much to their own profit, and would often save needless criticism of editorial policy. To illustrate what we mean, we will quote from the the November issue. On page 159, engineering edition, in an abstract from a paper, "Modern Machinery and Its Future Development," the following expression appeared:

$$\text{Cost per piece in cents} = \frac{\text{Wages per hour in cents} + \dfrac{\text{Price of machine in dollars}}{125}}{\text{Number of pieces made per hour}} + \frac{\text{Cost of tools and setting up in cents}}{\text{Total number of pieces}} + \text{cost of material per piece in cents.}$$

This formula, for such it is, is expressed in kindergarten form, but please take notice how confused it is, how easily its meaning may be mistaken, and how long it takes to really figure out what the meaning of the formula is.

Now, if instead of using this form, we indicate each element by a letter, and define each letter, we will note a great improvement in the clearness of the expression. There are no typographical mix-ups as to what is a numerator or what is a denominator, or where the expression begins and leaves off.

Let W = wages per hour in cents,
P = price of machine in dollars, divided by 125,
C = cost per piece, in cents,
N = number of pieces made per hour.
C_{ts} = cost of tools and setting up, in cents,
T = total number of pieces,
C_m = cost of material per piece, in cents.

Then, instead of the cumbersome expression referred to, we have the following:

$$C = \frac{W + P}{N} + \frac{C_{ts}}{T} + C_m$$

* * *

The correspondents to MACHINERY, who send us descriptions of special tools for publication, would greatly increase the value of their contributions if in every case they made it a rule to plainly describe, in the first place, what the tool is to be used for, showing, generally, an illustration of the piece to be produced or to be worked upon. This would make it a great deal easier to at once grasp the idea. To simply describe a device, without making clear its use, or what parts it is to produce, often makes the descriptions almost valueless, or of much less value than they might have. It is, therefore, desirable to proceed in a logical manner when describing a tool or device: First, explain what the tool is intended for, showing the piece operated upon or produced; then, proceed to describe the device, showing how it produces the results desired; and, finally, if the making of the device involves operations of more than common interest, give a description of the manner of making the device last. If these simple rules are followed, the contributions will be of greater value to the readers, and less time will be required of the editors for preparation.

SCREW THREAD SYSTEMS.*

ERIK OBERG.†

Notwithstanding all that has been written about standard screw thread systems, data which completely cover all the recognized standards are very scattered, and it is often necessary to search for information in many different handbooks and works of reference. For this reason a review of the most important information regarding the more common screw thread systems has been compiled in the following article. While a great many more systems than are here reviewed have been proposed from time to time, only those which have been officially recognized by mechanical men, or which have gained prestige by means of universal use and adoption, here or abroad, will be treated.

The United States Standard Thread.

The United States standard thread, usually denoted U. S. S., has a cross section as shown in Fig. 1. The sides of the thread form an angle of 60 degrees with one another. The top and bottom of the thread are flattened, the width of the flat in both cases being equal to one-eighth of the pitch of the thread. In this connection it may be appropriate to define the expression pitch as well as lead, as these two expressions are very often confused, and the word pitch, in particular, often, through erroneously, used in place of "number of threads per inch." The pitch of a thread is the distance from center to center of two adjacent threads. It is equal to the reciprocal value of the number of threads per inch, or, if expressed in a formula:

$$\text{Pitch} = \frac{1}{\text{Number of threads per inch.}}$$

The lead of a screw thread is the distance the screw will travel forward if turned around one complete revolution. It is evident that for a single threaded screw the pitch and the lead are equal. In a double threaded screw, the lead equals two times the pitch, in a triple threaded, three times, etc. The definitions given for pitch and lead should be strictly adhered to, as great confusion is often caused by improper interpretation of the meaning of these terms. Confusion is also caused by indefinite designation of multiple thread screws. The most common way to state the lead and the class of thread is perhaps to say *¼ inch lead, double*, which means a screw with a double thread, which, when cut, has the lathe geared for four threads per inch, but each thread is cut only to a depth corresponding to eight threads per inch. The same condition is also expressed by: *4 threads per inch, double.* These two ways of expressing the number of multiple threads are both correct, but the expression which ought to be used in order to avoid misunderstanding under any circumstances would be: *¼ lead, ⅛ pitch, double thread.*

Returning to the form of the U. S. S. thread, we find that if the thread is flattened one-eighth of the pitch at top and bottom, the depth of the thread is equal to three-quarters of the depth of a corresponding thread, sharp both at top and bottom. If p equals the pitch of the thread; d, the depth; and f the width of the flat, the following formulas express the relation between these quantities:

$$p = \frac{1}{\text{Number of threads per inch.}}$$

$$d = \tfrac{3}{4} \times p \times \cos 30^\circ = 0.64952\,p.$$

$$f = \frac{p}{8}$$

Formula for the Number of Threads in the United States Standard Thread System.

In order to fix definitely the number of threads per inch corresponding to any given diameter in the U. S. S. system, Mr. William Sellers, its originator, proposed the following approximate formula:

$$p = 0.24 \sqrt{D + 0.625} - 0.175,$$

in which formula p equals the pitch of the thread for any bolt or screw of the diameter D.

This formula is applicable to all screws ¼ inch and larger in diameter. For diameters below ¼ inch the formula is modified so as to read:

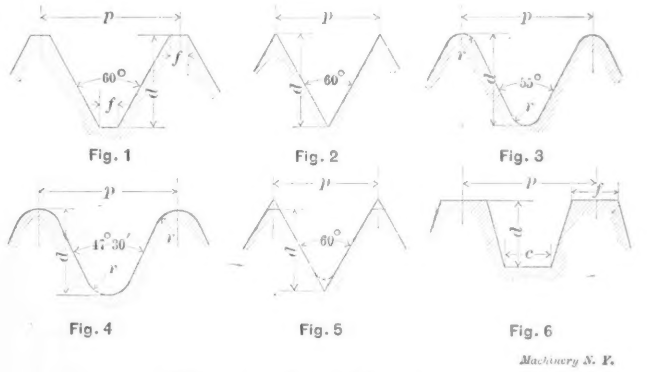
$$p = 0.23 \sqrt{D + 0.625} - 0.175,$$

This modification, which has met with general acceptance, changing the coefficient 0.24 to 0.23, was proposed by Mr. George M. Bond in 1882. The purpose of the change was to make the formula applicable to screw threads for bolts smaller than one-quarter inch in diameter. Mr. Bond's formula tends to increase the number of threads more rapidly as the diameter decreases, a distinct advantage in the case of small screws.

It will be proper to remark in this connection that screws 11/16, 13/16 and 15/16, which according to the formula given ought to have 10, 9 and 8 threads per inch, respectively, are in usual manufacturing practice made with 11, 10 and 9 threads per inch, respectively.

The Sharp V-thread.

The sharp V-thread, Fig. 2, is very similar to the U. S. S. thread, except that theoretically it is not provided with any flat, either at the top, nor at the bottom of the thread. In



Figs. 1 to 6. Standard Screw Threads.

common practice, however, it has proved necessary to provide this thread with a slight flat on the top of the thread. The reasons for this were referred to in a short article in the engineering edition of MACHINERY, October, 1906. In this article the difficulties caused by providing a flat on the top of sharp V-threads were also mentioned, the principal one being that no definite standard for this flat has been settled upon. Some manufacturers have used the same flat as is used for the Briggs standard pipe thread, which, although theoretically rounded at top and bottom, is, in this country at least, made with a small flat on the top of the thread. The width of this flat is selected so as to give exactly the same angle diameter as is obtained when rounding the thread in accordance with Briggs' original proposition. This flat is equal to about one-twenty-fifth of the pitch.

If p equals the pitch of the thread; d, the depth; and f, the width of the flat on the top of the thread, the following formulas express the relation between the various quantities of the sharp V-thread:

$$p = \frac{1}{\text{Number of threads per inch.}}$$

$$d = p \times \cos 30^\circ = 0.86603\,p.$$

$$f = \frac{p}{25}$$

Attention must be called to the fact that the formula for the width of the flat is selected simply to give an arbitrary value, which is *not* recognized as any *standard element* of the sharp V-thread. In figuring the depth of the thread, this flat is not considered, and the depth is arrived at as if the thread were exactly sharp.

Comparison between the U. S. S. and the Sharp V-thread.

The two standards referred to hitherto are the two forms of thread most commonly used in the United States. The objections to the sharp V-thread, as compared with the U. S. S. thread, are that the comparatively sharp points of the teeth

* The following articles relating to screw thread systems have been previously published in MACHINERY: Whitworth vs. Sellers Thread, May, 1899; Screw Pitches in Foreign Countries, February, 1900; Screws, September, 1903; Proposed Standards for Machine Screws, June, 1906.

† Associate Editor of MACHINERY.

are very frail; that the groove at the bottom of the thread, being sharp, facilitates fracture under strain; that the depth of the thread, being considerably greater than that of the U. S. S. thread, subtracts from the effective area at the root of the thread of the screw, thus impairing the tensile strength of the threaded bolt, and finally, that in case of taps, the sharp V-thread has less endurance and shorter life, and is capable of smaller duty, owing to the frail and easily worn away points of the thread. In spite of all this, however, the sharp V-thread will long continue to be in general use, primarily because it has so thoroughly established itself in the mechanical industries. This form of thread has also another very strong claim, because of being admirably adapted to the making of steam-tight joints. It answers this purpose best of all common forms of thread, and all patch bolt taps, boiler taps and staybolt taps are, as a rule, provided with sharp V-threads.

The Whitworth Standard Thread.

The Whitworth standard thread, Fig. 3, is used chiefly in Great Britain, but to a certain extent also in the United States. Its use here, however, has greatly diminished since the U. S. S. thread commenced to gain general approval. The Whitworth standard is the older one of the two, and was the first recognized screw thread system. In the Whitworth standard thread the sides of the thread form an angle of 55 degrees with one another. The top and the bottom of the thread are rounded to a radius determined by the depth of the thread, which is two-thirds of a thread with the same angle which were sharp at top and bottom. The radius at the top is the same as the radius at the bottom. If p and d equal the pitch and the depth of the thread, respectively, and r the radius at the top and bottom, then

$$d = \frac{2}{3} \times \frac{p}{2} \times \cot 27^\circ\ 30' = 0.64033\ p.$$

$$r = 0.1373\ p.$$

The advantages of the Whitworth thread are that screws with this form of thread have all the strength possessed by screws with U. S. S. threads, and at the same time have no sharp corners from which fractures may start. Screws and nuts with this form of thread will work well together after continued heavy service when other forms of thread would fail. Whitworth threads are used in the United States chiefly on special screws, such, for instance, as screws for gasoline needle valves, where a liquid-tight and yet working fit is desired. It is also often used for locomotive boiler staybolts. The objections to the Whitworth form of thread are that the angle of 55 degrees cannot be measured or simply laid out with ordinary tools, and that the rounded corners at the top and bottom cannot be produced with any degree of accuracy without great difficulty. The Whitworth standard screw system is denoted B. S. W. (British Standard Whitworth screw thread) in Great Britain.

British Standard Fine Screw Thread.

The British standard fine screw thread is a system of threads recently adopted in Great Britain. The form of the thread is the same as that for the Whitworth standard, but there are a greater number of threads per inch corresponding to a certain diameter in the Whitworth system. The fine screw thread system is denoted B. S. F., and applies to screws ¼ inch in diameter and larger. For detailed information regarding this system see the article in MACHINERY, October, 1906, entitled British Standard Fine Screw Thread.

The pitches for the system of fine screw threads are based, approximately, on the formula:

$$P = \frac{\sqrt[3]{d^2}}{10},$$ for sizes up to and including one inch; and on the formula:

$$P = \frac{\sqrt[8]{d^5}}{10},$$ for sizes larger than one inch in diameter.

In the above formulas

P = pitch, or lead of single-threaded screw, and

d = diameter of screw.

This standard is not intended to make the regular Whitworth standard thread superfluous, but simply supposed to offer a possibility of a standard fine screw thread for such purposes where the regular Whitworth standard would be too coarse.

British Association Standard Thread.

The British Association standard thread is the standard system for screws of small diameter in Great Britain. It is, however, hardly used at all in the United States, except in the manufacture of tools for the English market. The characteristics of the thread form are similar to those of the Whitworth thread, but the angle between the sides of the thread is only 47 degrees 30 minutes, and the radius at the top and bottom of the thread (see Fig. 4) is proportionally larger, depending upon that the depth of the thread is smaller in relation to the pitch than in the Whitworth standard thread. If p, d and r signify the pitch, the depth, and the radius at the top and bottom of the thread, respectively, then

$$d = 0.6\,p. \qquad r = \frac{2\,p}{11}$$

The various sizes of screws in this system are numbered, and a certain number of threads per inch always correspond to a certain given diameter. The system is founded on metric measurements. It was first originated in Switzerland as a standard for screws used in watch and clock making. This system is therefore also at times referred to as the Swiss small screw thread system.

Briggs Standard Pipe Thread.

The Briggs standard pipe thread is made with an angle of 60 degrees. It is slightly rounded off, both at the top and at the bottom, so that the depth of the thread, instead of being equal to the depth of the sharp V-thread (0.866 × pitch), is only four-fifths of the pitch, or equal to $\frac{0.8}{n}$, if n be the number of threads per inch. The difficulty of producing a thread with rounded top and bottom has, however, caused the manufacturers in this country to modify the original standard. Instead of rounding the bottom of the thread, it is made sharp as shown in Fig. 5. The top is slightly flattened instead of rounded, the flat being carried down just far enough to tangent the top circle of the correct thread form. This thread, as indicated by the name, is used for pipe joints and for many purposes in locomotive boiler work. Taps for producing Briggs standard pipe thread are provided with a taper of ¾ inch per foot on the diameter.

Whitworth Standard Thread for Gas and Water Piping.

The form of the Whitworth standard thread for gas and water piping is simply the regular Whitworth thread form, and the only difference from the regular Whitworth standard is the number of threads per inch. Manufacturers of taps, when making what is called English pipe taps, use the Whitworth form of thread and the number of threads according to the Whitworth pipe thread system, but make the dimensions for the taps the same as for the Briggs standard in all respects. The taper is also made the same as for the Briggs standard, or ¾ inch per foot.

Square Thread.

The square form of thread is usually made about twice as coarse in pitch as the V or U. S. S. threads, and partly for this reason and partly because of the perpendicular sides of the thread, it is a troublesome thread to cut with taps and dies. There is no standard for the number of threads corresponding to a certain diameter. The depth of the thread is equal to the width of space between the teeth, this space being equal to one-half of the pitch. While theoretically the space between the teeth is equal to the thickness of the tool, each being one-half of the pitch, it is evident that the thickness of the tooth must be enough smaller than the space to admit at least an easy sliding fit. This form of thread is largely used in adjusting and power conveying screws.

The Acme Thread.

The Acme thread, shown in Fig. 6, has of late become widely used, having in most instances taken the place of a square thread on account of its better wearing qualities, and the comparative ease with which this thread can be produced.

Of all standard thread systems the Acme thread is the only one which has a standard provision for clearance at the top and bottom of the thread. The screw is made of standard diameter, but the nut is made over-size. The relationship between screw and nut is illustrated in Fig. 7. If the diameter of the screw is A over the top of the thread, and B at the foot of the thread, the corresponding diameters of the nut are $A + 0.020$ and $B + 0.020$ inch. The sides of the thread form an angle of 29 degrees with one another. Considering the screw only, if p is the pitch; d, the depth of the thread; f, the width of the flat at the top of the thread; and c, the width of the flat at the bottom of the thread, then:

$$d = \frac{p}{2} + 0.010 \text{ inch},$$

$$f = 0.3707\ p.$$

$$c = 0.3707\ p - 0.0052 \text{ inch}.$$

The Acme thread has many good points, not the least of which is its strength, and the ease with which it may be cut compared with the square thread. This thread is recommended as a substitute for, and to be used in preference to, the square form of thread.

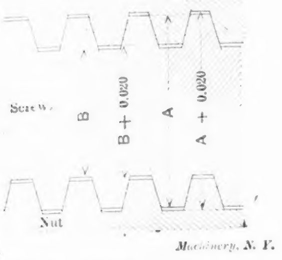


Fig. 7. Acme Standard Screw and Nut.

French and International Standard Threads.

The French and international standard threads are of the same form as the U. S. standard, and the formulas given for the latter form of thread apply to the former. The pitches, however, are stated in the metric measure, and are somewhat finer for corresponding diameters than the U. S. S. thread. This is a distinct advantage, especially in the smaller sizes. The standard thread of the international system is denoted S. I. and was adopted by the International Congress for the unifying of screw threads held in Zürich, 1898. This system conforms with slight variations with the system earlier adopted in France, the French standard thread, denoted S. F. In order to provide for clearance at the bottom of the thread in the nut, the congress referred to above specified that clearance at the bottom of the thread shall not exceed 1/16 of the height of the original triangle. The shape of the bottom of the thread resulting from such clearance is left to the manufacturers. However, the congress recommends rounded profile for said bottom. By this provision choice is given to the manufacturers to make the bottoms of their threads flat or rounded as desired, and yet have them conform to a common standard so as to interchange.

Instrument and Watchmakers' System.

The standard screw system of The Royal Microscopical Society of London, England, is employed for microscope objectives and the nose pieces of the microscope into which these objectives screw. The form of thread is the Whitworth form, the diameter of the male gage is 0.7626 inch. The number of threads per inch is 36.

WHITWORTH STANDARD THREAD SYSTEM FOR WATCH AND MATHEMATICAL INSTRUMENT MAKERS.

Diameter of Screw, inches.	No. of Threads per inch.	Diameter of Screw, inches.	No. of Threads per inch.	Diameter of Screw, inches.	No. of Threads per inch.
0.010	400	0.022	210	0.050	100
0.011	400	0.024	210	0.055	100
0.012	350	0.026	180	0.060	100
0.013	350	0.028	180	0.065	80
0.014	300	0.030	180	0.070	80
0.015	300	0.032	150	0.075	80
0.016	300	0.034	150	0.080	60
0.017	250	0.036	150	0.085	60
0.018	250	0.038	120	0.090	60
0.019	250	0.040	120	0.095	60
0.020	210	0.045	120	0.100	50

In the table above are given the sizes and corresponding number of threads for Whitworth standard screw thread systems for watch and mathematical instrument makers. This system is adopted by many instrument makers both in the United States and Europe.

Lag Screw Threads.

There is no recognized standard for the sizes and corresponding number of threads for lag screws. The following table, however, gives the number of threads according to common practice. While lag screws are largely made according to this system, there are, however, a number of different systems in use.

Gas Fixture Threads.

Thin brass tubing is threaded with 27 threads per inch, irrespective of diameter. The so-called ornament brass sizes have 32 threads per inch. The standard diameters of the thread are 0.196 inch (large ornament brass size) and 0.148 inch (small ornament brass size).

LAG SCREW THREADS.

Diameter of Screw.	No. of Threads per inch.	Diameter of Screw.	No. of Threads per inch.
$\frac{1}{4}$	10	$\frac{5}{8}$	5
$\frac{5}{16}$	9	$\frac{11}{16}$	5
$\frac{3}{8}$	8	$\frac{3}{4}$	5
$\frac{7}{16}$	7	$\frac{7}{8}$	4
$\frac{1}{2}$	6	1	4
$\frac{9}{16}$	6	...	..

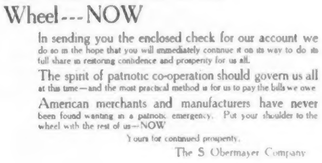
Fine Screw Thread Systems.

We have previously referred to the British fine screw thread system recently adopted. There is a demand for the adoption in this country of a standard system with a U. S. S. form of thread but with a finer pitch than called for by this standard. The Association of Licensed Automobile Manufacturers has adopted such a standard, but it is, of course, not universally recognized. The objection to the adoption of a standard by a single body of manufacturers is obvious. Even if the standard is one which would recommend itself to general use, it would be better if the opinion and the needs of machine builders in general were considered. On the other hand it may be said in defense of the adopted system that automobile construction is so specialized a manufacture that here doubtless may arise requirements which would not present themselves elsewhere.

* * *

KEEP MONEY MOVING.

We hope that by the time this note is published the tight money trouble will be over and business will have resumed its normal channels. Whether it is or not, the advice contained in the little slips here reproduced is worth taking to heart by every business man:


Put Your Shoulder to the Wheel---NOW

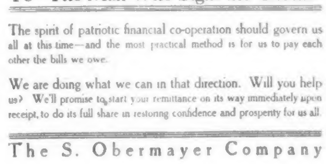
In sending you the enclosed check for our account we do so in the hope that you will immediately continue it on its way to do its full share in restoring confidence and prosperity for us all.

The spirit of patriotic co-operation should govern us all at this time—and the most practical method is for us to pay the bills we owe.

American merchants and manufacturers have never been found wanting in a patriotic emergency. Put your shoulder to the wheel with the rest of us—NOW

Yours for continued prosperity,

The S. Obermayer Company


To "The Man Who Signs the Checks"

The spirit of patriotic financial co-operation should govern us all at this time—and the most practical method is for us to pay each other the bills we owe.

We are doing what we can in that direction. Will you help us? We'll promise to start your remittance on its way immediately upon receipt, to do its full share in restoring confidence and prosperity for us all.

The S. Obermayer Company

The cause of business panics is fear, *i. e.*, simple cowardice. They belong in the same class as the stampede, caused in a crowded theater by some hare-brained monkey yelling "Fire!" when he has smelled only the smouldering butt of a bad cigar. But the majority does not stop to investigate. Men and women rush madly out, tearing clothes, bruising flesh and breaking bones as they go. The saner-minded set an example in calmness by quietly staying in their places. So it should be in the business world. In time of money trouble the solid business man who has his own best interests and those of the community at heart, will not withhold payment of debts as they come due so that he can hoard his cash. On the contrary, he will pay them with more than usual promptness, if possible, and so help "keep the ball a-rolling."

* * *

The results of the trials with the new turbine German cruiser, *Stettin*, are given by the *Mechanical Engineer*, as follows: The ship achieved a speed of 24 knots within 1 minute, 8 seconds, of starting the engines, and came to a dead stop, from full speed, in 1 minute, 45 seconds.

LAYING OUT CAMS FOR RAPID MOTIONS.*

F. H. SIBLEY.†

We may consider a cam mechanism as being made up of two elements. As generally constructed, one element is a revolving plate, cylinder, cone or sphere, and the other element is a bar or a roller which has some form of reciprocating motion. The revolving piece is usually made the driver, although the mechanism may be made to work in the reverse order. The shape of a cam will depend upon the kind of motion that the follower is required to have: The motion of cams that are used for driving parts of machinery may be one of four kinds, *viz.:*

1. *Uniform motion,* in which the follower is made to pass over equal spaces in equal intervals of time.
2. *Intermittent motion,* periods of motion being interrupted by periods of rest.
3. *Simple harmonic motion,* in which the follower is accelerated from rest to a maximum velocity and then retarded again to a state of rest, following the harmonic cycle.

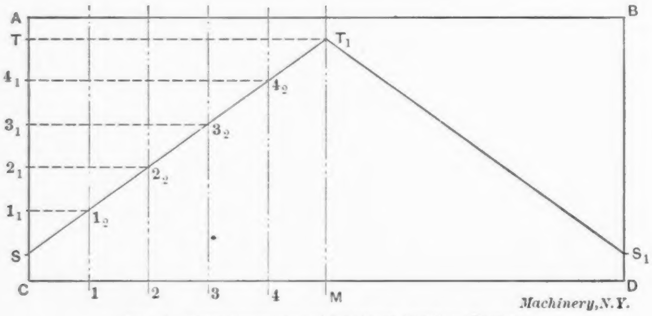


Fig. 1. Development of Uniform Motion Curve.

4. *Uniformly accelerated motion,* in which the follower is accelerated from rest to a maximum velocity and then retarded again to a state of rest, the acceleration being uniform, as, 1 inch per second, 2 inches per second, etc.

In slow-moving machinery it may not be important whether the follower moves with uniform, simple harmonic, or uniformly accelerated motion, but in machines where the cams have a high rotative speed, and the follower a reciprocating motion, as in the case of sewing machines and in some textile machinery, a uniform rate of motion will be unsatisfactory or impossible. The reason for this is that the follower is impelled from rest to its maximum velocity instantly, and also brought to rest from a maximum velocity instantly. This gives it a sudden jerk at each end of the motion, which is very trying to a machine when the reversals take place rapidly. Cams for high rotative speeds, where the follower has a reciprocating motion, should, therefore, be so designed that the follower will start gradually, attain its maximum speed near the middle of its path, and then gradually come to rest. In other words, the follower should have a uniformly accelerated motion during the first half of its movement, and a uniformly retarded motion during the last half.

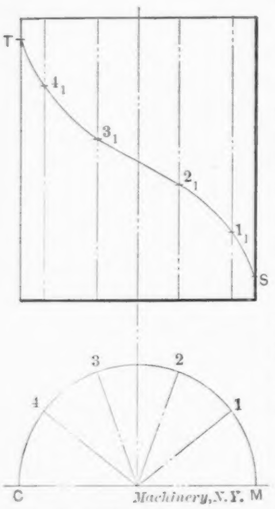


Fig. 2. Uniform Motion Curve scribed on Cylindrical Surface.

In uniformly accelerated motion $S = \frac{1}{2} Pt^2$ where $S =$ the distance passed over, $P =$ the acceleration and $t =$ the time. This is the same as saying that the distance which the body has passed over at the end of any number of units of time varies as the square of the number of such units. For example, if a body has a uniform acceleration of 2 inches per second $S = \frac{1}{2}$ (2) $(1)^2 = 1$ for the first second; $S = \frac{1}{2}$ (2) $(2)^2 = 4$ for the next second; and so on. This is also the law of falling bodies whose motion is not resisted by the air or other medium. Uniformly retarded motion obeys the same law. If the time intervals of such a motion be plotted as abscissas and the corresponding space intervals as ordinates, with reference to coordinate axes, the resulting curve will be a parabola, and this is the curve that should be used for the outline of cams that are designed for high rotative speeds.

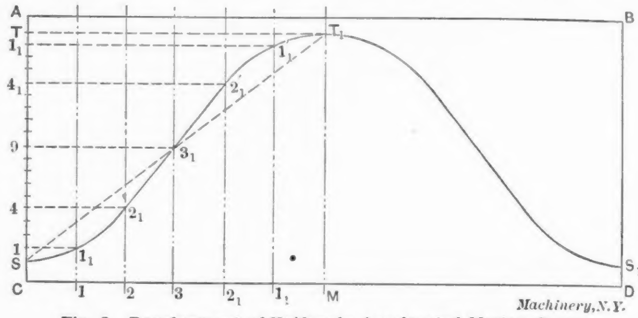


Fig. 3. Development of Uniformly Accelerated Motion Curve.

The cams shown in the following sketches do not necessarily represent any existing forms; they simply illustrate how the principle may be applied to certain shapes of cams and paths of followers. In Fig. 1, lay out on a sheet of paper $ABDC$ a line constructed as follows: Bisect CD at M and divide CM into any convenient number of parts, say five. Lay off on CA any distance ST, and divide ST into the same number of parts as there are in CM. Through the points 1, 2, 3, etc., on CM, erect perpendiculars to CM, and through the points 1_1, 2_1, 3_1, etc., on CA, draw parallels to CM intersecting the perpendiculars at points 1_2, 2_2, 3_2, etc. A line ST_1 drawn through these intersections will be straight. The line T_1S_1 can be found in the same way. Now if the sheet of paper $ABDC$ be wrapped around the outside of a cylinder

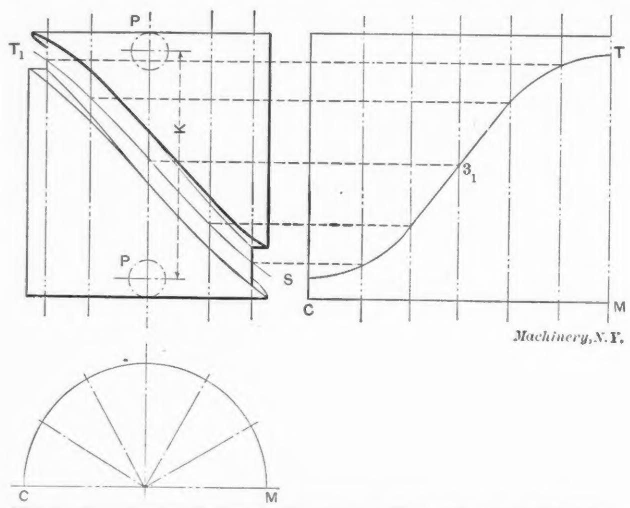


Fig. 4. Transferring Uniformly Accelerated Motion Curve to Cylinder.

whose circumference is equal to the distance CD, the line ST_1 will take the position ST, Fig. 2, and the line T_1S_1 will form a similar curve on the reverse side of the cylinder. If this curve be made the center line of a groove, as the cylinder revolves on its axis, the groove will drive a follower up and down, parallel to the elements of the cylinder, with a uniform speed. The follower will start and stop at either end of its motion with a sudden jerk.

In Fig. 3 let $ABDC$ represent the paper as before. Bisect CM at 3, and ST at 9. Divide $C3$ and $3M$ into any convenient number of parts, say three; then divide $S9$ and $9T$ into the square of three parts, or 9, as shown. Erect perpendiculars to CM at the points 1, 2, 3, etc., and draw parallels to CM through the points 1, 4, 9, 4_1, and 1_1. Through the points S and T_1 and the intersections 1_1, 2_1, 3_1, $2'_1$ and $1'_1$, draw a smooth curve. This line will be a parabolic curve, reversing at 3_1. The curve T_1S_1 is constructed in the same way. Now wrap the sheet of paper $ABDC$ around a cylinder whose circumference is equal to CD. The curve will take the position ST_1, Fig. 4, and the curve T_1S_1 will take a similar position on the reverse side of the cylinder. A groove made with these curves as center lines will drive a follower P up

* For additional information on this subject, see "Notes on Cam Design and Cam Cutting," August, 1907, and other articles there referred to.

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and down through the distance K, as the cylinder is rotated on its axis. The follower will start gradually at S, attain its maximum velocity, and then come gradually to rest again at T_1, the motion being uniformly accelerated and retarded. The sides of the groove are made parallel to $S\,T_1$, and drawn at a distance away from it equal to the radius of the follower P.

Fig. 5 shows the distortion of the curve $S\,T$ when the follower moves in the arc of a circle, with center at some point Q, instead of in a straight line. Points on the new curve are found by setting off from the intersections $b_1\,d_1$, etc., the ordinates $a\,b$ and $c\,d$. The curve $S\,a_1\,c_1\,T$ is then made the center line of a groove which will drive the hinged follower with the same variation in speed attained by the follower in Fig. 4.

Fig. 6 shows how the parabolic curve is applied to a plate cam. The roller follower is supposed to oscillate between P and P_1 as the cam rotates about O. The curve $P\,3_2\,P_1'$ corresponds to $S\,T_1$ in Fig. 4, being the center line of the parabolic groove in the face of the plate. Only one-half of the cam is shown in the figure. Suppose this cam is to rotate 180 degrees, while the follower moves from P to P_1. Draw the base circle with radius $O\,P$, the length of which will depend upon the size of the cam. Draw $O\,A$ perpendicular to $O\,P$, and divide the arc subtended by $P\,O\,A$ into any convenient number of parts, say three. Draw radii $O1_2$, $O2_2$, etc. Divide $P\,P_1$ into two equal parts at 9, and divide $P9$ into the square of three parts, or 9, as shown. With O as a center, and radius $O1$, find the intersection 1_2. In the same way find the other intersections 2_2, 3_2, etc., and draw a smooth curve through these points. This curve has the same relation to the curve of uniform motion shown dotted, that the parabolic curve has to the straight line in Fig. 3. If a similar curve be laid out on the other side of $P\,P_1'$, and made the center line of a groove then the follower P will be pushed up and down mechanically by direct contact. If a curve parallel to $P3_2\,P_1'$, and drawn at a distance equal to the radius of the follower away from it, on the inside, be made the outline of the cam, then the follower will be pushed up mechanically to P_1, and allowed to fall by its own weight. It will remain in contact with the cam theoretically, because the principle of uniformly accelerated motion is the same as that of a falling body. In practice, however, the friction and the inertia of the connected parts would probably prevent the follower from remaining in contact with the cam on its return motion if the oscillations were rapid.

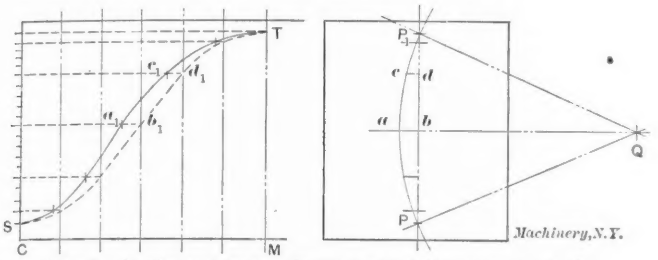


Fig. 5. Accelerated Motion Curve, when Follower moves in the Arc of a Circle.

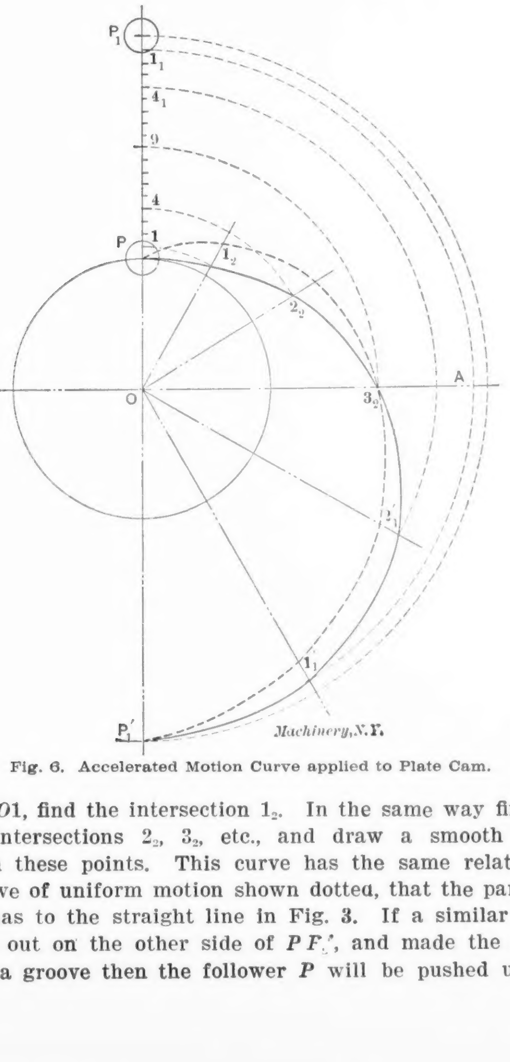


Fig. 6. Accelerated Motion Curve applied to Plate Cam.

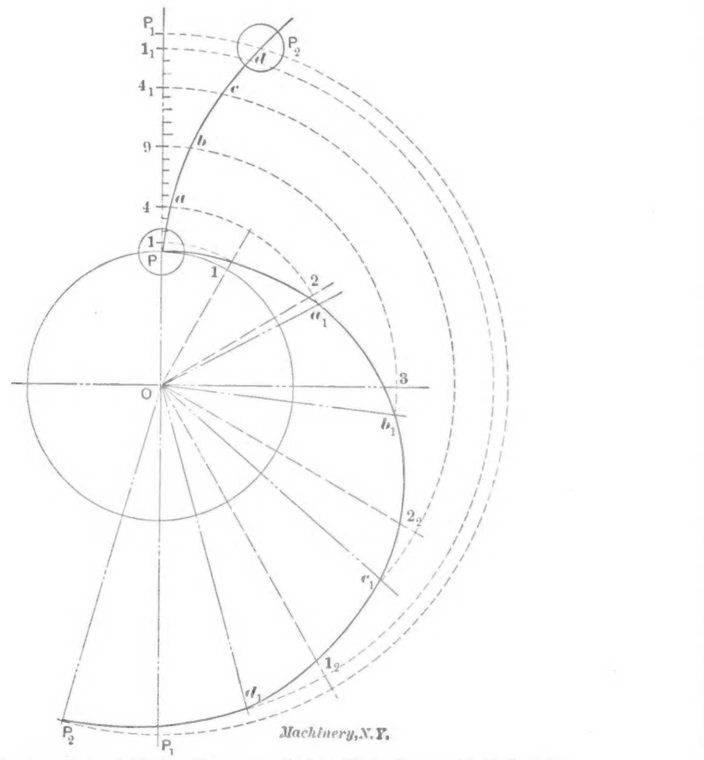


Fig. 7. Accelerated Motion Curve applied to Plate Cam, with Follower moving along a Curve.

Fig. 7 shows the parabolic cam constructed for a follower which moves in any curved path. The construction is the same as in Fig. 6 except that points in the curve are located on radial lines Oa_1, Ob_1, etc., offset from the first radii by the distances $2a_1 = 4a$, $3b_1 = 9b$, and so on.

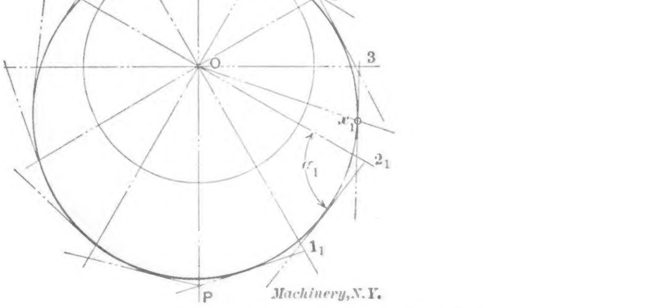


Fig. 8. Plate Cam for Bar Follower.

When a plate cam is to be laid out to drive a bar follower through a certain cycle of operations, the construction is more complicated. The base circle is divided as in the previous case into any convenient number of parts and the square of the number of such parts laid out from P to 9 and from 9 to P_1, Fig. 8. If the bar is to oscillate about Q as a center, it will take the positions $Q1$, $Q4$, $Q9$, etc., as the radii $O1$, $O2$, $O3$, etc., come to the position OP. The intersections 1, 2, 3, and so on, are found just the same as in the previous cases. Now instead of drawing the curve for the cam outline through these

points, straight lines which represent the edge of the follower must be drawn through the points making the same angle with a given radius as the follower makes with *OP* when the radius in question is in the position *OP*. For example, angle a equals angle a_1. Now the cam outline is a smooth curve drawn tangent to these straight lines. If the bar follower, instead of being centered at Q, moves up and down parallel to its first position, then all these angles are right angles. If the face of the bar is curved, then the cam outline must be drawn tangent to the curves after they have been properly located with respect to their several radii.

In drawing cams like Fig. 8, the proper relation between the diameter of the base circle and the distance PP_1 must be assumed. If the base circle is too small, the cam outline will not be tangent to the edge of the follower in all positions, and the latter will not have uniformly accelerated and retarded motion. There is a rolling and sliding contact between the cam and its follower in the case of Fig. 8. The rolling action tends to carry the point of contact outward to the right of *OP*, during the upward motion, and to bring it back towards *OP* during the downward motion. The point of contact x does not necessarily occur when Ox_1 is perpendicular to Qx.

* * *

VERTICAL CAMERA BRACKET.

ETHAN VIALL.*

In photographing small objects that cannot be readily hung up or pinned to the wall, one is often at a loss to know how to get a satisfactory picture. This is especially true of drills, reamers and objects of that class, and makeshifts of various kinds are resorted to to hold the camera in a vertical position in order that the articles may be laid on the floor.

None of the camera catalogues that I am familiar with list a bracket for this purpose, and so I made one, which is strong, rigid, and answers every requirement. It is easily carried in the camera case, taking up but little room. My camera is a large, heavy, view camera, and so the bracket I made is heavier than would be needed for a light instrument.

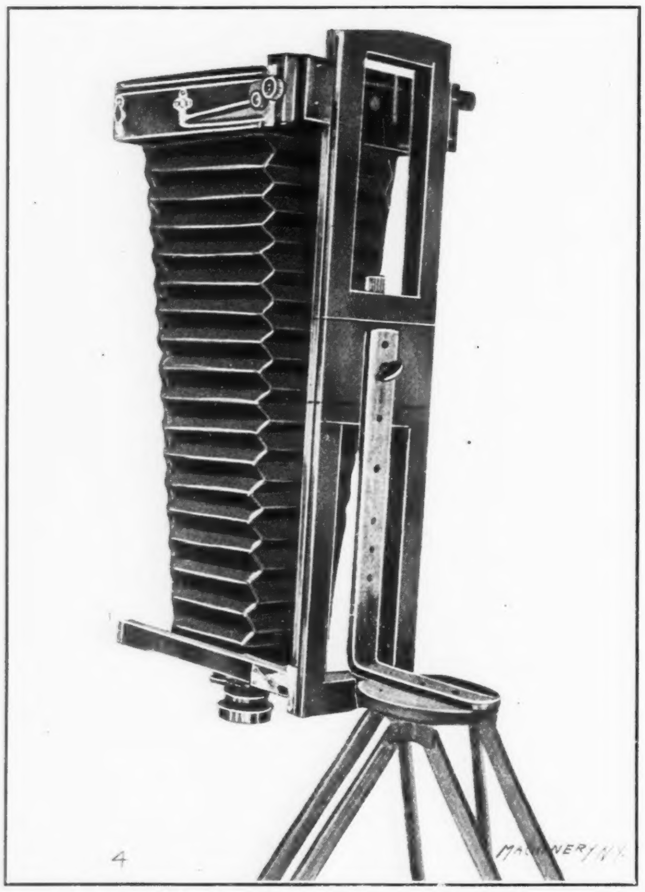


Fig. 1. Bracket in Use with Long Arm screwed to the Camera.

The bracket was made of a flat piece of stiff steel, ¼ inch thick, 1¼ inch wide, and 18 inches long. This was bent into the form of an L, the long arm being 12 inches and the short one 6 inches long. Holes were drilled and tapped in several places in each arm. These holes were tapped the regular ¼ inch 20 threads, used almost universally for camera fittings. A thumb-screw similar to the one in the tripod top was made. The bracket was polished and was then ready for use.

In Fig. 1 the camera is shown with the bellows drawn out full length and the camera fastened to the long arm. This position is often very convenient. For copying pictures I generally use the long arm down, as this position, with the bellows extended, brings the lens close to the floor.

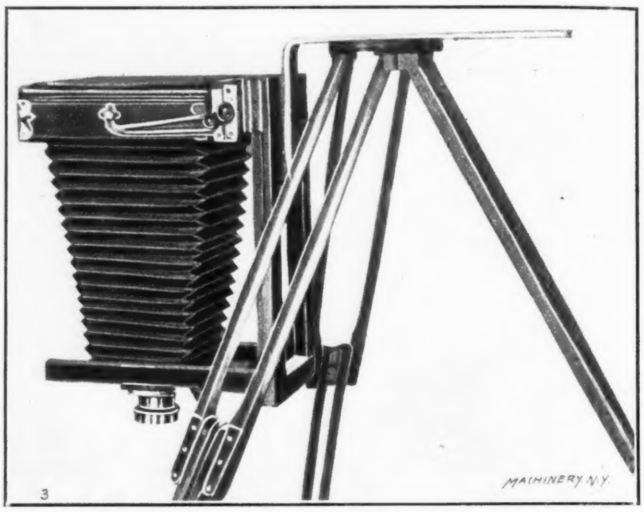


Fig. 2. Bracket in Use with Short Arm screwed to the Camera.

Fig. 2 shows the bracket in place with the short arm screwed to the camera, and the long arm extending over the tripod top. This was done so that if it were necessary to set the tripod legs in such a position that the camera would overbalance, a weight could be hung on the long arm. In ordinary work where the tripod legs are properly spread no tendency to tip is noticed.

A photographer will soon find that this bracket quickly pays for the hour's time taken to make it, and he will wonder how he ever got along without it. By using the different holes in the bracket and the adjustments of camera and tripod, any position may be obtained as one using it will quickly see.

* Address: 805 N. Mercer St., Decatur, Ill.

* * *

A committee of the Chicago Association of Commerce has reported adversely on the question of the inauguration of a parcels post, proposed by the Postmaster-General. The chief objection stated is that a parcels post would involve a much larger annual loss in the running of the post office department than is at present the case. A number of other reasons are also mentioned, amongst others, that it would cause the government to enter into business competition with private concerns. This probably is, if it were possible to analyze the true reason of the opposition, the main objection. The monopoly of the express companies must, by all means, be considered, even if the public at large is the loser. While it seems that a question of this kind does not strictly pertain to mechanical matters, such as are dealt with in MACHINERY, it is still worth while mentioning the fact, because it is undeniable that the benevolent influence that would in reality be the result of a parcels post, would react on all kinds of business in the country, placed on a legitimate basis, and therefore it is in the interest of mechanical men, as well as others, that reforms of this character are carried through. Progress in one direction always tends to stimulate progress in all other lines.

* * *

A CORRECTION.

An error was made in the note, appearing in the December issue, which described a novel machine foundation built in the Stockbridge Machine Co.'s shop, Worcester, Mass. The machine erected on this foundation is a Bullard "vertical turret lathe." This machine was described in our October issue on page 119, engineering edition.

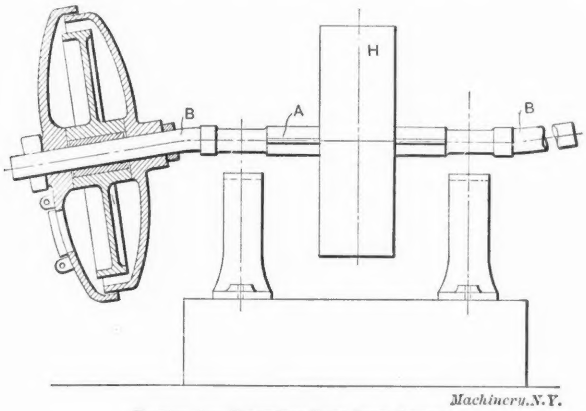
ITEMS OF MECHANICAL INTEREST.

NOVEL USE OF ELECTRIC FLAT-IRONS.

It is not often that heating units from electric flat-irons are put to as severe a test as in the instance given below. The problem was to replace a crank-pin on the high-pressure side of a 500-horse-power cross-compound Russell engine. The new pin, 6 inches diameter with a taper of 1/64 inch, was to be fitted into a crank-disk, 5 inches thick, which was fixed on a 12-inch shaft. To expand the disk by heating it with blow-torches would have taken too long, besides making a dirty and unsatisfactory job, so several heating units from General Electric 6-pound flat-irons were grouped around an iron core 3¼ inches diameter, and placed in the 6-inch hole in the crank-disk. In four hours after the current was turned on the disk had expanded sufficiently to allow the crank-pin to slip in. Although the heating units were at about white heat all of the time, they were not injured except that the brass tubing on two was slightly melted in one place. After having served for fitting the crank-pin, the heating units were replaced in the flat-irons and continued in their normal use.

CLEANING CAST GEARS.

Some time ago a new procedure for cleaning cast iron gears from scale and molding sand was shown in the *Zeitschrift für Werkzeugmaschinen und Werkzeuge.* This process consists in placing the gear inside a casing, together with any desired cleaning material, the casing being fastened on a bent shaft, so that when revolved, the whole mechanism gets a kind of



Device for Cleaning Cast Iron Gears.

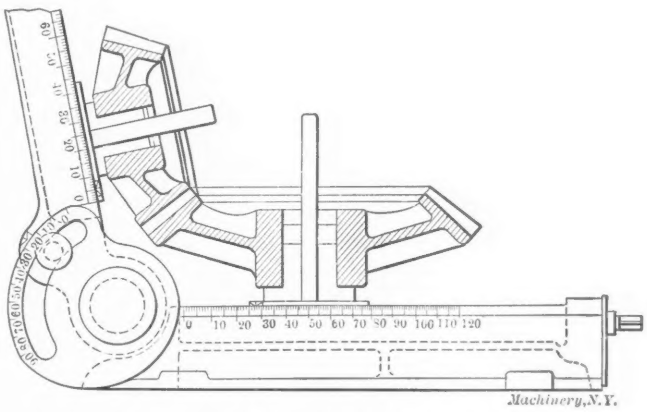
oscillatory motion. Referring to the cut herewith, *A* is a shaft having bent portions *B* at each end. The device is driven by pulley *H* on shaft *A*, to each of the bent portions of which gear wheels are clamped. The advantage of making the apparatus double, that is of having a bent portion on each end of the shaft, the bends being made in opposite directions, is to secure a balance at the high rotation of speed desirable. A perfect balance, however, cannot be obtained in this manner, as it is easily seen that the cleaning material, for instance, will not be distributed equally in the casings, but will always tend to fall toward the bottom, thus preventing a balanced condition to be produced. At anything but the very highest speeds, however, this question of balancing cannot be of very great importance in an apparatus of this kind.

R. G.

GERMAN BEVEL GEAR TESTING DEVICE.

A recent issue of the *Zeitschrift für Werkzeugmaschinen und Werkzeuge* contains a description of a fixture for testing bevel gears. As shown in the cut, it is essentially a protractor, provided with sliding blocks carrying pivots on which are mounted the gears to be tested. Besides the protractor graduations for setting the gear axes to the required angle, graduations are provided for showing the setting longitudinally of the sliding blocks on the two arms. The only use we can see for these graduations would be in case the device was opened out to 180 degrees, and used for testing spur gears, in which case it could be set to give the required center distance. In measuring bevel gears the angle is generally a matter of prime importance, the hub lengths being fitted to suit. As may be seen, the lower member or bed of the device is provided with a traversing screw for adjusting the sliding block, carrying the pivot and the gear; doubtless the upper one is also so arranged. Means are provided for clamping all adjustments after they are made.

This device serves the same purpose as those made for sale in this country by firms making a specialty of gear-making

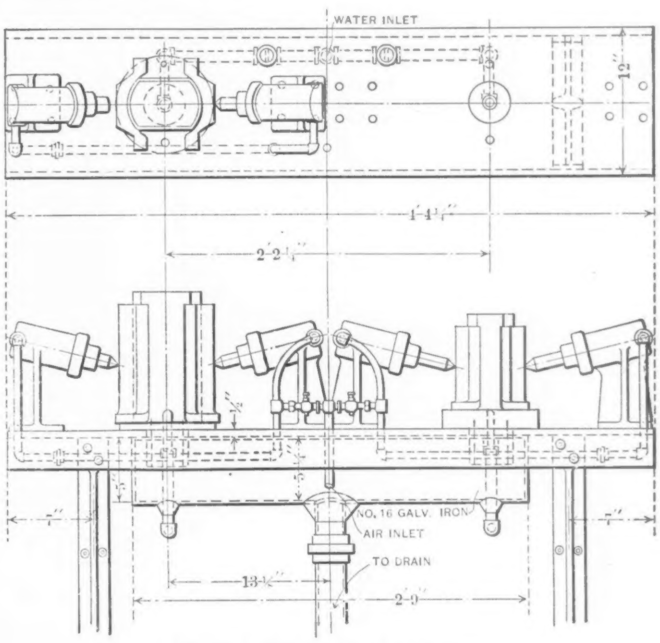


Protractor for Testing the Accuracy with which the Teeth of Bevel Gears are cut.

machinery. They are in common use in gear cutting. Such advantage as this particular device appears to have lies in its comparative smallness and lightness, and being a fixture or bench tool rather than a complete machine.

LINING CAR BRASSES.

The accompanying cut reproduced from the November issue of the *American Engineer and Railroad Journal*, shows a device in use at the Collinwood shops of the Lake Shore & Michigan Southern Railway, for lining car brasses. The apparatus consists of two pairs of air cylinders, suitably mounted on a 12-inch channel beam, as shown. The cylinders are bored to 2 3/16 inches diameter. The piston rod is inclined downward and pointed at the end, so that, when air is admitted to the cylinders, the brasses are held firmly against



Device for Holding the Car Brasses.

the mandrel. A coil spring is fitted in the cylinder, so that, when the pressure is released, the piston will be forced back, and the brass can easily be removed. The mandrel is cored hollow, and streams of water are played on the inside by means of a pipe cap with four ¼-inch holes in it, which is placed on the end of the supply pipe, thus cooling the lining metal as it is poured. Guide strips are cast on each side of the mandrel to hold the brasses the proper distance from it. The brasses are tinned before lining.

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

FEBRUARY, 1908.

PAID CIRCULATION FOR JANUARY, 1908, 23,286 COPIES.

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

HINDLEY WORM GEARING.

It is generally conceded by designers and intelligent users of worm gearing that the Hindley or hour-glass worm has certain advantages over the common type, and they will in the same breath describe its disadvantages. Its chief advantage is that it fits the worm-wheel over a considerably greater area than is possible with the ordinary worm. The larger area of contact reduces the pressure per unit of surface, and that means better lubrication, longer wear and less frictional resistance. Its disadvantages are that it must be exactly located, it is not interchangeable with worm-wheels of the same pitch but of greater or less number of teeth, and it must be made by special machinery. The disadvantages of non-interchangeability and of requiring special machinery are probably least important; but to locate the Hindley worm exactly and preserve that location are not easy. Change of position due to wear of the thrust bearing does little or no harm to the common worm, but it is absolutely ruinous to the Hindley type. Notwithstanding the drawbacks, its superior efficiency and longer life have made its use considerable. Curiously, however, there is an almost total lack of published data on dimensions, and we would gladly receive contributions on the subject for our data sheets.

* * *

ARE SPRING AND WEIGHT EQUIVALENTS?

In United States patent practice a mechanical equivalent has been legally defined as that which performs the same function in substantially the same manner as the compared device. A recent decision (1905) holds that a spring and weight are equivalents in certain competitive plumbing fixtures, inasmuch as one effects the same action as the other in the infringing device. The decision undoubtedly is sound for the case in contention; but, unfortunately, it reads further on: "The interchangeable use of springs and weights is the stock illustration for equivalents."

Our criticism is that the "stock illustration" holds good only when springs and weights *are* interchangeable; and this condition exists within a narrow range only, as every engineer knows. Springs and weights are not broadly interchangeable. A weight must act in accordance with the law of falling bodies. It can fall at no greater speed than expressed by the formulas $v = gt$, or $s = \frac{1}{2} gt^2$; whereas a spring, having little weight in proportion to the energy exerted within a narrow range of action, may, because of its less inertia, perform functions in a small fraction of the time required for a weight. Hence, a weight often is inoperative where a spring works successfully. Again, a difference of great importance is that a weight must act in a direction toward the earth, or that approximately. A spring, of course, works practically as well in one direction as another.

Now, if the stock illustration means that a spring and weight are equivalents *only* when interchangeable, and being thus interchangeable because of the limitation implied, then there is nothing more to be said. Otherwise the statement is loose and technically untrue, and tends to show that scarcely anything is more difficult than exact definition.

* * *

CHOOSING A TRADE.

The choice of a trade, though important, is often made without investigation. Boys enter a trade blindly, with little understanding of what they are to learn or the position their chosen occupation occupies in the world's affairs. They do not know whether it is lasting or ephemeral. For that matter, of course, no one can judge with certainty of the permanency of any skilled occupation; but we may infer much from past experience and a knowledge of its relative position in the general manufacturing industry. We know that once flourishing trades have become obsolete because of changed customs, improved machinery, exhaustion of materials, etc.; and the skill acquired by their craftsmen is now of no value. Such changes, if they come quickly, are little less than tragedies to the individuals directly affected.

The beginner then should, first of all, get an idea of the probable permanency of his proposed occupation, the prospects for advancement and the possibilities it offers as compared with others. To do this thoroughly is a considerable undertaking, and one beyond the intelligence of most boys; but their mature friends often could prevent bad mistakes if they would make even superficial investigations.

New occupations are constantly springing up. Some of them will be of long duration and well paid, but the majority are short-lived and to be avoided by the prudent. Of all the trades in existence, probably there is no other that is as important or that offers the same permanency as the machinist's trade. It is a basic art upon which all other manufacturing industries depend. In olden times the blacksmith was the chief craftsman, inasmuch as he made tools for all the rest—and for himself; but the supremacy of the blacksmith long ago departed. The cold working of metals has very largely displaced forging to shape while in the hot and plastic state, and, in machine construction forged work now enters to a very small extent. Many tools and machines are made in which the primitive art of the blacksmith appears in no shape whatever. The rolling mill shapes the shafting, and itself is the product of the machine shop. The lathe, drill, planer, shaper, milling machine, power press and other metal-working tools have almost entirely displaced the smith. Now it is the machinist and machine shop that produce tools and machines for all manufacturers. The machine shop is the fountain head of all modern mechanical industry. All machinery of every description, the printing press, sugar mills, hoisting machinery, locomotives, stationary and marine engines, etc., are the product of the machine shop and the skill of the machinist, machine designer and mechanical engineer. So it may be reasonably claimed that no trade to-day offers as much security as those which have to do with the operation of machine tools and the hand processes which should be included in the education of an all-around machinist.

The demand for skilled machinists is growing, and it will continue to grow with the years. We speak of this as a mechanical era, but we are only at its beginning. Not all can be machinists, of course, no matter how great the development; but the fathers who read MACHINERY can safely advise their sons and their friends' sons who have an inclination in that direction, to enter the trade. Specialization which tends to keep the rank and file employed merely as operators, gives all the more opportunity to the bright and ambitious.

LOOK FORWARD.

The bright side is the one to look for always, and the man who has the ability to find it possesses a source of strength that, with work, is almost certain to triumph over difficulty. We should not overdo it as was the case with some of the daily newspapers that recently published misleading reports of trade revivals, doing more harm than good. The more evenly each of us keeps balanced just now, the better it will be for all; and somewhere between the extremes will be found the facts which every business man needs to shape his course.

An investigation of conditions in our branch of the machinery industry shows that since January first there has been considerable general improvement and as much as could be expected of recovery, after the staggering blows in the last months of 1907. The situation is fundamentally sound. Money is becoming more plentiful. Confidence is gradually returning, and although the days go by slowly now, before the end of the year, stronger and perhaps wiser, we shall be looking forward to another period of prosperity.

* * *

PRODUCTION AND USE OF DENATURED ALCOHOL.

The annual report of the Commissioner of Internal Revenue, just issued, shows that the production and use of denatured alcohol has not yet attained much importance in the United States. It states that only ten stills have been set up for producing denatured alcohol, and it is claimed that the cost of the product is much greater than that confidently predicted at the time the industrial alcohol law was passed by Congress. It is further alleged that the present prospects for denatured alcohol competing actively with kerosene and gasoline are not at all encouraging. Those who worked hard for the measure feel considerably disappointed that the good results experienced in Germany have not been realized here.

In our opinion it is still too soon to feel disappointed and discouraged that denatured alcohol has not quickly become an important internal combustion engine fuel or a general illuminant. The change on the part of the public requires time, and time is also required by distillers to get their plants into efficient working shape. Moreover, the internal revenue regulations first prescribed were quite sufficient to discourage any would-be small producers. They were required to work under conditions but little less rigorous than those prescribed for the regular distillers of liquors for general consumption. The revised regulations which went into effect September 1, 1907, are much less restrictive, and considering the nature of the business, are probably all that can be asked for.

There is still another factor to reckon with, and that is the effect of nearly fifty years of stern enforcement of the laws against illicit distilling. Possible small producers have a dread of doing something that will subject them to the wrath of the internal revenue officers, and coupled with that feeling is the prejudice existing in many communities against engaging in a business that is seemingly contrary to temperance sentiments. The fact that the product is distinctly not for drinking will not immediately remove that prejudice. Initiative in production has also been lacking, because of general ignorance of the business, but when the ice is once broken there will be numerous small plants started, no doubt.

While it is possible to make alcohol from almost all vegetable refuse, it appears that it is not profitable under present conditions to make it from corn or other grains. Potatoes offer the cheapest source of alcohol at the present time, but even they are somewhat too costly. It is safe, however, to predict that the ingenuity of our inventors and the enterprise of our manufacturers will develop processes which will utilize the vast quantities of vegetable refuse now rejected and wasted.

We therefore believe that although the farmers have not yet gone into the making of denatured alcohol in large numbers, the prospects for its general industrial use are bright. Prejudice, the opposition of the vested interests, uncertainty as to the meaning of government regulations, and ignorance of the business in general have been quite sufficient to hold back its development. With time will come more knowledge and experience, and a greatly reduced cost of the product, with the correlative of enormous use.

* * *

PIRATING SPECIAL MACHINE TOOLS.

Some months ago an incident was brought to our notice which illustrates the peculiar folly into which machine tool builders sometimes fall; that is, pirating special machinery. It is a practice of which we have recently heard little, for almost all manufacturers have had about all they could do to attend to their own work, but as business slackens such incidents may increase. The moral aspect of such competition is elusive, and we will merely point out its unprofitableness in general.

There are those who build special machines intelligently, with the wisdom of long experience in similar lines of work and a comprehensive idea of the needs of the work. Their would-be competitors build with a hazy knowledge of the special requirements, and only a general idea of the essential features of design. The last are copyists; or, more plainly speaking, pirates, who do not hesitate to steal the ideas of men who have spent years to perfect features of machine design.

The incident referred to centers around a Western manufacturing concern which bought a heavy special machine tool from an Eastern builder. It was for a purpose and of a design which precludes a general sale; perhaps not more than five or six could be sold in the whole United States. The concern in question having purchased one machine found that they needed another, but, although the price was satisfactory, could not get delivery from the builders as soon as desired. Thereupon, another machine tool company, young at the business, and of the "unafraid" type, tackled the job and produced a copy of the first machine which was delivered two months earlier than the time stipulated by the Eastern builder. But the pirating concern, building the second machine, lost money, or at least made no profit—and the purchaser got a poor machine. It appears from this incident that three concerns were losers; whereas if strictly legitimate business methods had been followed, there would have been a satisfied customer, a machine sold at a profit, and profitable employment for the "butting in" concern at its own particular business, in which it excels.

To be a successful builder of special machinery, a concern must not only be a specialist in design, but in production as well when it enters into competition; and if this incident teaches any particular lesson it is simply that builders of special machinery make a mistake when they initiate cutthroat competition, because this branch of the machine tool trade generally yields only moderate profits at the best.

* * *

A committee appointed by the Association of Railway Superintendents of Bridges and Buildings to report on the action of sea water on concrete, has collected the opinions of a number of men engaged in work of this kind. The following statements embody the substance of the expressed opinions. Where there is no ice formation, concrete, if made in air with fresh water and then sunk into sea water, works well, but shows a tendency to disintegrate slightly on the faces between low and high water levels. Concrete should not be deposited direct into sea water. Where the salt water permeates the whole mass of the concrete, the faces disintegrate faster than where the concrete is mixed with fresh water and made in air and then sunk into position in the sea water. Between low and high water the faces of the concrete show a tendency to disintegrate. All opinions agree that concrete should be faced with granite above low water, on account of this tendency of the rise and fall of the tide to disintegrate the concrete. It is also agreed that frost and ice formation, where the tide rises and falls, has a greater tendency to disintegrate the concrete. It will be recollected that, in a note in the engineering review of MACHINERY, October, 1907, we mentioned an article on this subject contributed by Mr. M. H. Le Chatelier to the *Annales des Ponts et Chaussées*, in which he claims that all hydraulic binding agents used for cement and concrete may be decomposed by sea water.

ENGINEERING REVIEW.

CURRENT MECHANICAL EVENTS—LEADING ARTICLES OF THE TECHNICAL PRESS.

One of the most complete railroad testing laboratories in this country has been completed by the Union Pacific Railroad, at its new Omaha shops. This laboratory includes complete equipment for physical and chemical tests of all kinds, as well as bacteriological investigations, electrical experiments, metallurgy, etc.

The *Moniteur Industriel* mentions the fact that the "Compagnie des Omnibus" in Paris has found it to be greatly advantageous to use alcohol instead of petrol as fuel for their motor cars. In Paris the price of petrol, at the present time, is about 48 cents a gallon, while alcohol is sold at the price of 34 cents a gallon; but to obtain equal results 5 per cent more alcohol is required.

A new example of the industrial development of Japan has been given by the announcement of the fact that the new armored cruiser *Ibuki* was successfully launched only six months after the keel was laid. All the materials used were of Japanese make, and the building and launching of this vessel is considered in ship building circles as marking an epoch in the history of naval construction in Japan.

It is stated that a new British torpedo boat destroyer, the *Mohawk*, is the fastest vessel in the world. She maintained for six hours at her official trial an average speed of 34¼ knots, and for six runs over a measured mile the speed was 34½ knots, which is equal to about 40 statute miles per hour. The vessel is fitted with steam turbines and uses oil fuel. The oil consumption is so low, comparatively, that the vessel will have a much wider radius of action than have much slower vessels.

The *Journal of the Franklin Institute* contains some interesting figures regarding the magnitude of the Baldwin Locomotive works. According to the figures given, the men employed are about 19,000. The horse-power employed in steam and oil engines amounts to nearly 17,000, and the consumption of coal per week is 3,000 tons, and of iron, 5,000 tons. The machinery is largely driven by motors, there being 1,115 motors in the works, representing 14,200 horse-power. The area of the buildings comprises 6 1-3 acres.

It is stated by the *Zeitschrift des Vereines Deutscher Ingenieure*, which journal had this information from an English source, that the cost of repairs on the English cruiser *Amethyst*, which is driven by steam turbines, has been decidedly lower than the repair costs on vessels of the same type driven by reciprocating engines. If the cost of maintenance of turbines, as compared with that for reciprocating engines, should, in general, prove to be lower, this will be one very important point in favor of the turbine.

An assistant professor at the Paris University, Mr. George Urbain, claims to have discovered a new metal, by separating the element ytterbium into two component parts. The new element he gave the name of *lotherium*, and he is preparing to present a complete report upon the subject before the Academy of Science. According to the *Scientific American*, Mr. Urbain states that he has already made a number of researches regarding the new element, and observed its different characteristics by chemical tests, and that he has come to the conclusion that it possesses some new properties, which will make it of great interest, from a scientific point of view.

In an article on pressure gages in the August 30, 1907, issue of *Engineering*, a few interesting facts about high pressure gages are stated. It is there mentioned that the highest mercury column is that placed in a well at Butte-aux-Cailles, France, which is about 1,650 feet high, and records up to 660 atmospheres. The next highest is that in a mine near St. Etienne, France, which is about 1,330 feet high, recording 530 atmospheres, and the one on the Eiffel tower 1,000 feet high, recording 440 atmospheres. The highest mercury column in England is at the Municipal Technical College at Manchester, which is only 175 feet high. In these very high mercury columns, it is of course impossible to use glass tubes from top to bottom. Steel or iron tubes are, therefore, used with glass tubes fixed either at regular intervals up the entire height, or at those points only where readings of pressures are likely to be taken.

The opening of the famous Simplon Tunnel, under the Alps, between Switzerland and Italy, referred to several times in our columns, has placed the people of the village of Simplon, located by the old Simplon Road, which runs over the Alps at this place, in a rather curious position, and instead of facilitating their communication with their fellow-countrymen, it has made communication somewhat difficult. Since the opening of the tunnel, the highway is not kept open in the winter, but it can be traveled down on the Italian slope, and, thence, it is possible to return to Switzerland by the tunnel, but if any goods are taken along, they have to pass through the custom-houses of Italy, and then, returning to Switzerland, the custom-houses of that country, and cattle are subject to inspection as exports from Switzerland to Italy, and then, within a couple of hours, as exports from Italy to Switzerland. The highway is closed from October to May.

It is stated in *Mercator* that a railway ferry connection between Sweden and Germany has now practically been settled upon. This railway ferry will make it possible to run direct passenger trains from Berlin to the principal Scandinavian cities. As terminals for the ferry, Trelleborg in Sweden and Sassnitz in Germany have been selected. These two points are about 65 miles distant from each other, and the crossing of the Baltic is intended to be made in three hours and a half. The ferry is expected to be the largest railway ferry in Europe, having a length of about 365 feet. There already are railway ferry train connections between the cities on the Continent and the Danish Islands, and thence from Copenhagen by two routes to Sweden, but the present railway ferry will make it possible to shorten the time considerably, and to run trains from the Continent through to Sweden and Norway, without touching Denmark.

A recent report of the ship-building industry in the United States, issued by the Census Bureau, indicates a constant, though not as heavy an increase as has taken place in other industries. The years compared are 1880 and 1904. In the former year the capital invested was approximately $21,000,000, but in 1904 the investment had increased to $121,600,000, the number of employes increasing from about 21,000 to nearly 51,000 in the same period. The value of the work done was about $37,000,000 in 1880, and about $83,000,000 in 1904. Since 1900 there has been an increase of over 50 per cent in the production of boats under five-ton rating, due to the development of gasoline engines for such craft. Although the number of vessels of five tons and over, launched during 1904, was 167 less than the number launched in 1880, the tonnage had increased 40½ per cent during this period. The average value of the vessels launched in 1880 was not quite $8,000, whereas in 1905 the average value was $32,700.

The secretary of the Civil and Mechanical Engineers' Society of Great Britain called a meeting January 2 at Caxton Hall, Westminster, to discuss the subject of standard notation for engineering formulas. The society asks the coöperation of other engineering societies and associations in this much-needed reform. Our American engineering societies and associations should give their attention to the matter, and, if possible, agree on a standard notation. Scarcely any books agree on the meaning of symbols save a few, and, con-

sequently much space is taken up by the ever-recurring explanations of the notations. Obviously, a symbol used in engineering formulas pertaining to any subject should invariably have a definite significance. The mixed notations now used cause much confusion, and are about on a par with the confused mess of screw thread systems which we had prior to the adoption of the Sellers standard. Engineers should recognize that standards in engineering literature are just as needful as in engineering construction. The Civil and Mechanical Engineers' Society ask that schedules of suggested symbols for use be submitted. These should be sent to the secretary, Mr. A. S. E. Ackermann, 25 Victoria St., Westminster, S. W., England.

According to a recent news item, a Chicago architect by the name of Yorke has devised an arrangement of elevators for tall buildings, which seems, on the surface, at least, to be reasonable as well as ingenious. The inventor proposes to have two elevators in each shaft in a twenty-story building. For instance, the first elevator would be loaded at the bottom floor for passengers for stories from the tenth to twentieth. The second elevator, meanwhile, will be in the basement, awaiting the filling of the first. After being filled, the first elevator will run express to the tenth floor, and thence distribute its load between there and the twentieth. The lower car has, meanwhile, been filling at the first story, and it starts on an upward distributing trip from the first to the tenth stories, reaching the tenth story at about the same time that the upper car does the twentieth. The operation is reversed when coming down, the first car collecting from the twentieth to the tenth and running express to the bottom, which the lower car, running local from the tenth has already reached, discharged its passengers, and descended out of the way to the basement.

The idea is, of course, to reduce the space required for elevators in very tall buildings. This is a serious matter when there are twenty stories or more, as a glance at the floor plan of any such building will show. It ought to be possible to provide the necessary safety devices for preventing the cars from colliding, and, if this is the case, the idea ought to be a feasible one. It is said that the plan is to be tried in the immediate future in buildings in both New York and Chicago.

An interesting note in the *Zeitschrift des Vereines Deutscher Ingenieure*, for December 7, 1907, makes mention of a new means of transmission of power, introduced by the Eloesser-Kraftband-Gesellschaft, Charlottenburg, Germany. The power transmitter employed is made of thin steel bands, used instead of leather belting or rope drive. These steel belts, as they may be called, run either on ordinary pulleys, the same as leather belts, or, better, over pulleys provided with a special covering for giving greater friction. The dimensions necessary for these steel belts may be most easily comprehended by referring to the dimensions of belts used in actual installations, which the company referred to has carried out. Powers from 200 to 250 H.P. with a belt speed of about 5,400 feet per minute, are transmitted with a steel belt 4 inches wide and 0.02 inch thick. It is stated that these steel belts need be made only about one-sixth the width required for leather belts, for transmitting the same power. This, of course, is a great advantage, as it permits pulleys to be much narrower, and, at the same time, permits the bearings for the shaft on which the pulley is mounted, to come much closer together, consequently permitting, in many cases, smaller diameter of shaft, as it often is the case that the diameter of a shaft has to be provided not so much for taking care of the turning moment produced by the transmission of the actual power, but for giving sufficient stiffness to resist the bending moment between the bearings. Another advantage, with this kind of belting, is that the steel belt does not lengthen when in use, at least, not to any appreciable extent, like the leather belt, and that a correct tension in the belt is far easier to obtain. Experiments with these steel belts, carried out by Prof. Kammerer, have shown that it is possible to run them at a peripheral speed of the pulleys of 12,000 feet per minute.

NOVEL USE OF THERMIT.

Industritidningen Norden, December 6, 1907.

Thermit, as our readers may recollect from former references made to this subject, is a welding process, invented in Germany, in which a mixture of aluminum and iron oxide is employed for welding. When the aluminum, which is introduced in a pulverized form, is ignited, it takes oxygen from the iron oxide, thereby producing aluminum oxide, and free iron. By this an enormously high heat is developed, estimated to be over 5,000 degrees F., so that the iron is easily melted, and this makes it possible to employ this means for welding. A new and peculiarly interesting example of the use of thermit has been proposed by the German inventor, Mr. Hasenkamp. In iron structures, particularly in the case of bridges where several members are in tension, it often happens that some of the members do not take their full share of the stress, or, in other words, that they would need to be shortened so as to take their share of the load. For correcting this, in many cases, the members have been taken down, and adjusted as to length through forging in an ordinary blacksmith shop. This way of doing the work takes a long time, is expensive, and, at the same time, it makes it necessary to stop the traffic on the bridge while this work takes place, to prevent any accident from failure of the remaining members. These difficulties are avoided by bringing the members to a red heat while in place, by means of thermit, at several points between their ends. In order to prevent the member from lengthening while it is hot, clamps are provided which are fastened at both sides of the place which is heated. These clamps are connected with one another by means of bolts, and these bolts take the stress while the member itself is brought to a high heat, at which time, of course, the member would be unable to take any stress, without increase in length. Adjusting the bolts connecting the clamps shortens the member to the desired degree and when the member cools off, it will remain short, the adjustment required having been effected. The process can be carried out in a few minutes, and stoppage of the traffic is unnecessary.

TRAINING OF APPRENTICES IN FOUNDRY WORK.

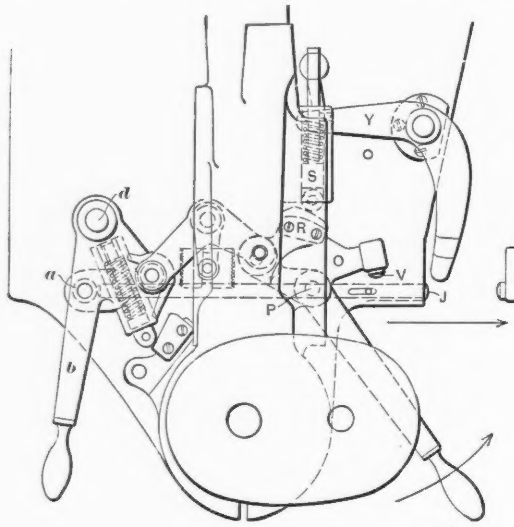
The Iron Trade Review, August 15, 1907

The foundries of the Ingersoll-Rand Co., located at Phillipsburg, N. J., employ some 900 men, and of these fully 98 per cent have been trained in the employ of the company. At a time when particular interest is taken in apprentice systems and industrial training, the plan carried out by this company merits attention. This plan was originally outlined eleven years ago, and, with some modifications, is still pursued.

The minimum age for enrollment of apprentices is fourteen years, and the course covers four years. The core department has been christened "The Kindergarten," as it is here that the embryo molder is first introduced to the mysteries of foundry practice. To acquaint himself with his surroundings, the boy is given only light duties to perform during the first few weeks of his employment, and his tutor, aside from the chief of the department, is a youth who has had not less than three months training. The pair work together during a similar period, when the one most advanced progresses to the side of another who has probably worked for nine months, and the three months' apprentice is charged with the duty of leading another through his first steps. This mode of procedure is carefully followed until the end of the first year, when the boy is graduated from the core department and his compensation increased from $1 to $1.25 per day. Instead of placing him immediately on the floor to acquire the rudiments of molding, he is intrusted to the tender mercies of the melter for three or four weeks, to obtain a knowledge of charging, melting, tapping, and cupola repairs. As a result of this practice every molder in the plant can melt successfully. Objections might be raised to the employment of the apprentices in such large numbers in the core department, but the success of the venture is indicative of the wisdom of this practice. The core boxes, largely metal, have been made practically "fool proof," and after a brief experience the most intricate shapes are produced in large

numbers daily. The boys are taught the various mixtures and the methods of baking, thus giving them the equipment of those making a specialty of core work. Nor is this apprenticeship system limited to boys alone, as laborers in the plant inclined to take up this trade are permitted to take up the course.

With the advent of the apprentice on the molding floor, he is made an assistant to another slightly more advanced, and in some cases works with an experienced molder. His lot is not that of an ordinary helper, as he is given every opportunity to advance, and as he masters the simpler sections, he



is given more complicated work. The supply of common labor is liberal, and such duties as are only too often associated with the learning of this trade and are styled as "breaking in chores," are left to the laborers to perform. The undivided attention and effort of the apprentice can thus be applied to obtaining a knowledge of his chosen calling, and his forward strides are consequently rapid. The mode of advancement in the core room applies in the molding department, and with the third year the daily wages are increased to $1.75. At this period many of the boys have the equipment of the average molder and are permitted to make those sections for which they are best fitted. During the fourth year many of the apprentices are paid the same wages as the skilled mechanics, as the question of pay then is governed alone by their ability. No agreements are signed by the company, nor is one required of the parents of the boys. If, after a reasonable period the apprentice shows no talent for the work, he is dropped, and the cause for this action is carefully explained. Notwithstanding the average ages of the employes, the discipline is remarkable. The only penalty is suspension for a week, and it is seldom that this must be enforced. Shop rules have never been posted and those that govern are such as are generally understood and are passed from one employe to another.

COMBINED AUTOMATIC VERTICAL AND HORIZONTAL FEED ON A VERTICAL MILLING MACHINE.

Zeitschrift für Werkzeugmaschinen und Werkzeuge, October 15, 1907.

A German machine tool builder, the firm of de Fries & Co., Düsseldorf-Heerdt, has brought out a vertical milling machine, having a rather peculiar feed mechanism. With this, the tool may first be fed a certain distance vertically into the work, and then a certain distance horizontally, the feed mechanism acting automatically, and being before hand adjusted to the required distance of feed motion. Feeds of this character are commonly required when milling keyways and slots with end mills. In Fig. 1 is shown a plan, front and side view of the most important parts of the machine, and in Figs. 2, 3, and 4, are shown the parts of the operating mechanism at different stages of the cut. Fig. 2 shows the mechanism while the end mill is being fed vertically into the work; Fig. 3 when fed horizontally, and Fig. 4 when the feed motion has been automatically thrown out of engagement at the end of the cut.

The feed mechanism is operated through a clutch *A*, Fig. 1, having teeth on both sides. This clutch is keyed to a shaft, which in turn is driven from the main spindle by a shaft *B* through a combination of spiral gears and worm-gearing. The clutch, while it cannot turn on its shaft, is, of course, free to move sideways into engagement with either of clutches *C* or *D*. When clutch *A* engages with clutch *C* on the hub of gear *E*, a screw *F* is turned through the medium of bevel gears *G*. A nut *H* is mounted on screw *F*, and the rotation of *F* feeds this nut downward, the nut on its downward motion bringing with it the sleeve *K* to which it is connected. The sleeve *K*, in turn, is fastened to the spindle bearings of the machine, and the spindle with its tool is thus fed downward by the downward motion of nut *H*. At the predetermined end of the downward feed, however, clutch *A*, though a mechanism which will be described later, is thrown out of engagement with clutch *C*, and engages clutch *D*, located on the hub of gear *L*. Through this gear the table of the machine is now

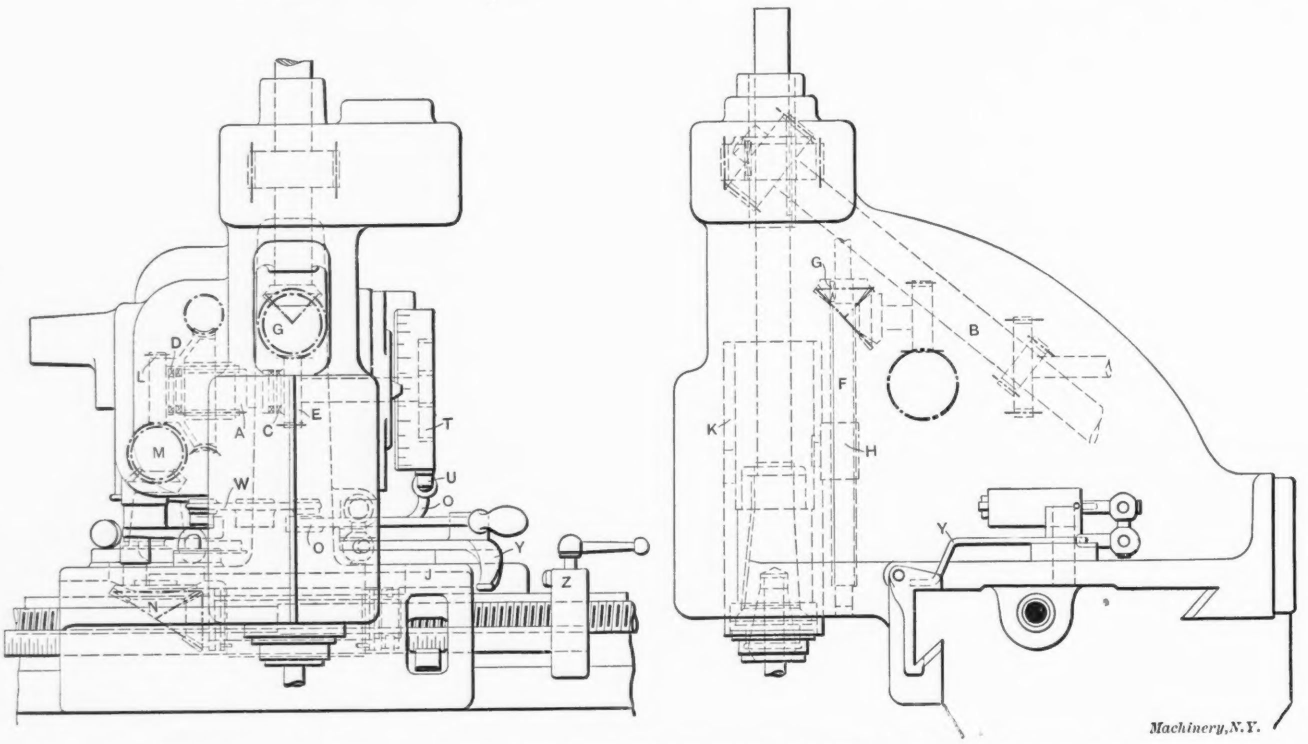


Fig. 1. General Arrangement of Vertical Milling Machine with Combined Automatic Vertical and Horizontal Feed.

fed forward, horizontally, by means of the intermediate gear drives *M* and *N*. At the end of the horizontal movement, the mechanism returns the clutch *A* to a middle position, so that all feed motion ceases.

If we now examine the mechanism operating the automatic feeds mentioned above, we will find it to consist of an ingenious combination of levers. The reference letters in the

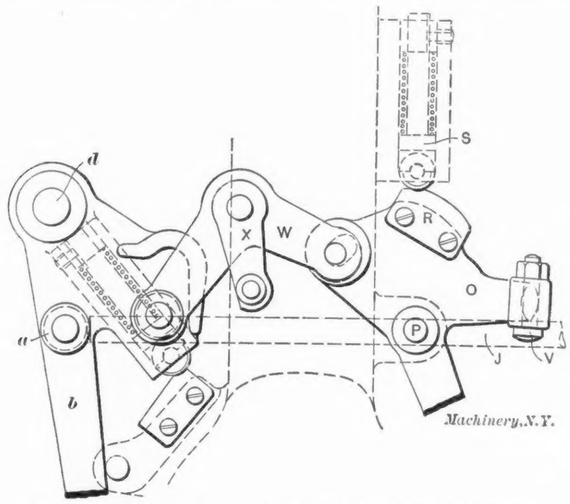


Fig. 2. Position of Levers during Vertical Feed Movement.

following refer to all the cuts with this article, it being necessary during the description, to refer from one illustration to the other, in order to adequately explain the construction. A lever *O*, turning around a stud *P*, is provided with a cam surface *R*, against which a plunger *S*, at its end provided with a roller, presses under the action of a spring. When the lever *O* is in the position shown in Fig. 2, the roller of plunger *S* rests on a surface of cam *R* which is at right angles to a line through the center of the plunger and the center of pivot *P*. Consequently, there is no tendency for the lever *O* to turn around its pivot under the action of the plunger and its spring. In order to make it possible to predetermine the amount of vertical feed, a graduated disk *T* is provided, on which an adjustable dog *U* is fastened. This dog is set by means of the graduations to any length of downward travel desired. When the tool has reached the end of its vertical travel, the dog *U* strikes a pin *V* in lever *O*, and turns this lever so that the plunger *S* with its roller descends on the inclined surface of *R*, thereby producing a quick turn-

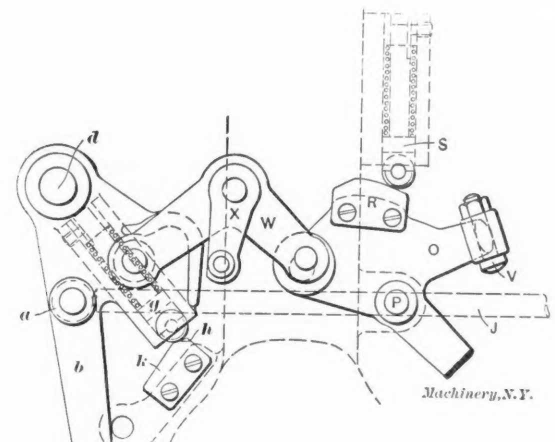


Fig. 3. Position of Levers during Horizontal Feed Movement.

ing motion around pin *P*. In turning, lever *O* also turns lever *W* around its pivot, and as lever *X* is fastened to lever *W*, the lever *X* is moved from its position in Fig. 2 to that in Fig. 3. The lower end of lever *X*, however, is connected to clutch *A*, and the motion imparted to this lever throws it out of engagement with clutch *C* and in engagement with clutch *D*, thereby throwing out the vertical, and throwing in the horizontal, feed.

This horizontal table feed is automatically stopped at the end of the cut by the following action of the mechanism. The plunger *S* is first withdrawn from its seat on cam surface *R* on lever *O* by means of lever *Y*, which, in turn, receives its motion from striking the dog *Z*, as the table advances. The lever *O* is then free to move, and if a force is exerted to return it to its position in Fig. 2, or to the position shown in Fig. 4, there is no resistance to be overcome. In the next place, a rod *J* is forced against dog *Z*, but as this rod is free to move in the table of the machine, it slides back in a direction opposite the direction of motion of the table, and finally, pushes against projection *a* of the lever *b*. It thereby turns lever *b* around its pivot *d* and, in doing so, permits a plunger *g*, operated in the same way as plunger *S*, previously referred to, to descend from a surface *h*, where it is in equilibrium, to an inclined surface *k*. The action of the spring back of plunger *g* then accelerates the motion of lever *b* until the roller at the end of the plunger rests at the lower corner of the inclined surface *k*, as shown in Fig. 4. The motion of lever *b*, however, causes a turning motion of lever *W*, as can be plainly seen from Figs. 3 and 4, and lever *X*, connected with

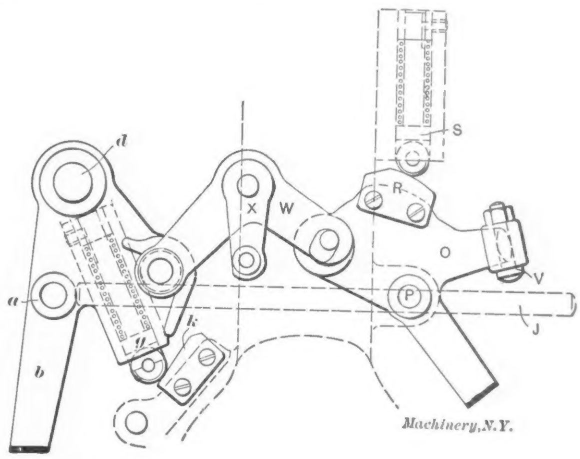


Fig. 4. Position of Levers when Both Feeds are thrown out.

clutch *A*, is turned back so that the clutch occupies a central position, not engaging with either feed motion. On account of the previous release of lever *O* from the pressure of plunger *S*, the return of lever *X* to its middle position is easily accomplished without the exertion of any great force back of plunger *g*. When a new piece of work is put into the machine the feed levers are returned to their original position by hand.

THE ART OF GALVANIZING.

Alfred Sang, in *Transactions American Foundrymen's Association.*

One of the most persistent problems which confront the worker in iron and steel is the prevention of corrosion. There are two general ways of preventing this corrosion, which might be called respectively the non-metallic and metallic methods. In the non-metallic method, the articles are coated with an organic substance, usually oil or varnish, the efficiency of which depends on its being more or less air tight. The metallic method consists in coating the iron with some other metal, and it is this method which will be discussed here.

Considered merely as a mechanical protection, the coating should be able to resist impact and abrasion, the latter being the most important. The soft metals, such as tin and zinc, do not stand up well against abrasion, but unless their adherence be very defective, they will stand impact well, on account of their malleability at ordinary temperatures. It would be desirable to obtain a coating which would be as good a protection as zinc but tougher and harder. Aluminum is being used with some success and if the metal were cheaper it would become an interesting competitor of zinc. This latter metal is, of all the commercial metals, the one which most closely fulfills all the requirements placed on a good coating. I shall, therefore, now proceed to describe the various processes which have been used to apply zinc to metal surfaces.

Cold Galvanizing.

In the early years of the last century the process of electrolytic zincing, which is nowadays known as cold or electro-galvanizing, was first discovered, but until about ten years

ago the lack of suitable equipment prevented its commercial application. The articles to be treated by this process are first thoroughly cleaned of scale, rust, and grease, by an acid pickle, sand-blasting, hot lye or by other means, singly or in combination, and are then placed as cathodes in a solution of some salt of zinc—usually the sulphate—in presence of zinc and which regenerate the solution, while a current of low voltage is passed through the arrangement and deposits zinc from the solution upon the articles.

The surface of an electrically galvanized article is matt or frosted, provided the work has been properly done. It always shows a few pores. If improperly done, or if the work was not perfectly clean before treatment, it is either honeycombed with pin holes or spongy. Above a certain limit of thickness, below which the coating is worthless, first class electro-galvanizing is superior to hot-galvanizing, and it is cheaper to produce where automatic machinery can be employed, although less zinc is deposited than by a hot dip. This is no doubt due to the better contact between the zinc and iron.

Hot Galvanizing.

Sixty years ago the process of hot galvanizing was introduced on a commercial scale. It consists in dipping the articles into a bath of molten spelter, with or without other metallic additions, at temperatures ranging from 750 to 900 degrees F. The articles must be first cleaned, as for electrolytic work, but a slight falling short of perfection does not have such disastrous effects on the quality of the work. Very heavy pieces may be heated before dipping, so as not to chill the bath. The coating is crystalline or amorphous, and does not adhere as perfectly as does the electrolytic one. Properly treated sheet metal goods have an attractive spangled appearance, but most articles look like castings, and sharp edges are lost. Metallic chlorides are used as fluxes. They are expected to remove the injurious salts of iron left by the pickling, but it is a question if they themselves are not the main cause of the decay which starts underneath the coating in hot galvanized work. The fumes given off in hot galvanizing are injurious to machinery, and in a manufacturing concern it is necessary to erect a separate building for this work.

Dry Galvanizing.

The latest process for applying a zinc coating is the dry process. This process of galvanizing or Sherardizing metals was awarded a gold medal at the St. Louis Exposition of 1904, and the President's gold medal for 1905 was presented to its discoverer by the British Society of Engineers. The inventor, Sherard Cowper-Coles, is one of the most eminent metallurgical engineers in Europe, and is well known for his reintroduction on a commercial scale of the process of electric galvanizing.

For the purpose of Sherardizing, the articles are placed, after cleaning, in a retort, usually a drum, and are covered with zinc-dust, which is commonly called blue-powder, and is the flue-dust, and, therefore, a by-product of the zinc smelting furnace known as the Belgian furnace. It contains as a rule from 75 to 90 per cent of pure zinc; the supply of zinc-dust is ample at a price below that of spelter, and if the demand increases it can be produced in any quantity that may be required. A small amount of powdered charcoal is added to prevent oxidation of the zinc by the air inside the retort at the beginning of the operation, and the receptacle is closed and heated to a temperature about two hundred degrees below the melting point of zinc. By Sherardizing, a homogeneous deposit of zinc is obtained, varying in thickness according to the length of time the article is allowed to remain in the retort, its lower portion being an alloy of zinc and iron or of zinc and copper, as the case may be. In the case of copper the alloy is a hard brass. The drum is occasionally turned a fraction of a revolution to insure an even coating where the articles are crowded together, and the heating may last from a few minutes to several hours, and two or three drums can be used in connection with one furnace.

A Sherardized surface resembles, in general appearance, an electrically coated surface. It is, however, of a soft silver-gray, more lustrous and metallic, and, on that account, it is to most people, more pleasing to the eye, and it is distributed with great uniformity, which is not the case in hot galvanizing. Whereas in hot galvanizing the amount of zinc which is alloyed to the metal of the article is very small and most of the coating forms an exterior perishable skin, in Sherardizing, the coating is thoroughly incorporated with the metal which it protects, forming an alloy having the appearance of pure zinc, but much harder and more durable. It is on account of this thorough alloying that the protection afforded by Sherardizing is superior to that afforded by either hot or electric galvanizing. The zinc having penetrated the iron, the old surface cannot be recovered by either chemical or mehcanical means.

If an excessive amount of zinc is deposited by Sherardizing, the outside surface is composed of zinc somewhat hardened by the presence of a small percentage of iron, and zinc-dust accumulates and clusters in a way which renders the surface rougher and less attractive. No special advantage is derived from the additional expense unless the conditions under which the articles are to be used are exceptionally severe.

The process of Sherardizing is not confined to zincing; the dusts of antimony and of other metals can be used in a similar manner. The fact that zinc-dust, even at temperatures higher than its melting point, does not melt or cake, is of great value in Sherardizing, as it eliminates the danger of spoiled work from carelessness in handling the temperature. Furthermore, zinc-dust containing as little as 35 per cent of pure metal can be used.

The Efficiency of Dry Galvanizing.

The efficiency of dry galvanizing has been proved by thorough testing both in England and Germany. Considered merely as a covering, it fits as closely as does an electrically-deposited coating, and it is impenetrable because of being free from pores or cracks. As a mechanical protection it resists both abrasion and impact better than work done either by the hot or cold galvanizing process, because of the qualities of the ferro-zinc alloy.

Commercial Scope of Dry Galvanizing.

It is a noteworthy fact that while many articles have appeared in technical and scientific journals about Sherardizing, not one word of criticism or denial of its claims has as yet been offered. The process has always appealed to scientific men because they are in position to appreciate the solid scientific foundations of its claims.

The new process has not entered the field as a competitor to galvanizing alone; in a great many instances it can take the place of coppering, of nickel-plating and of tinning, where the articles are not to be used for the preparation or handling of foodstuffs. To these I should add the large amount of copper and brass articles, from tubing to typewriter and sewing machine parts which are now nickel-plated. An interesting point in relation to the various methods of protecting metals is the price of the metals themselves. Nickel is 7¾ times, tin and aluminum 7 times, copper 4⅛ times, and antimony 3¼ times as high in price as spelter, and at equal efficiency against corrosion, the lightest coating is one of zinc as applied by dry-galvanizing. Analyzing the various items which go to make up the cost of Sherardizing, we find that in every instance there is a saving either over the hot process or over the electric process. A plant for Sherardizing is less expensive than a hot plant and very much less so than an electric plant.

Various Applications of Dry Galvanizing.

Sherardizing will not fill an uncalked seam and act as a solder; this is its one limitation but it has a great variety of new applications to make up for it. A brilliant and permanent polish which can hardly be distinguished from nickel-plating, but bluer and more like silver, and a better reflector of light, can be given to Sherardized articles by means of the usual burnishing tools and machines, but unlike nickel-plating it is absolutely rust-proof. This polish is not temporary like that of electro-galvanizing, and it is hard and durable if worked down, as it should be, to the ferro-zinc.

Sherardized aluminum can be electro-plated, and the objectionable soft surface be overcome, not to mention the finish and appearance. Sherardizing has been found to protect silver

from sulphated hydrogen, which blackens it, and it can be applied very lightly before polishing without altering the color. When aluminum has been Sherardized it can be readily soldered; this is expected to do away with the very unsatisfactory riveting of articles made from aluminum sheets.

SHAFT-TURNING MACHINE.

Bernh. Dreyer in *Werkstatts-Technik*, December, 1907.

The machine here described and illustrated has been designed for the purpose of overcoming some of the difficulties experienced when using cold rolled shafting, and the time wasted when straightening and turning shafting in an ordinary lathe. Machines, turning shafting according to the new method referred to, have been in use in Germany since 1901, and are installed in many of the leading machine shops.

The objections to straightening shafting in the ordinary way, with hammer blows, or, at best, with a shaft straightening device, is that this work is difficult to do, and consumes a great deal of time. Besides, internal stresses are often produced through the hammering and bending, which have an unfavorable influence on the strength of the shafting. The turning of long shafting in ordinary lathes is also difficult, takes a great deal of care and time, and requires a skilled operator, if straight work of uniform diameter is demanded. Cold rolled shafting does not answer the requirements for a high-grade shaft, as it is not perfectly straight, not fully round, and not always of the exact size required. The rolling process also produces internal stresses, which are likely to spring the shaft out of shape. That this is so is proved by cases where a shaft, apparently straight and of the correct diameter, afterward is found to produce considerable friction in the bearings, due to the distortion of the shaft. This often results in serious losses of power, or, at times, in complete derangement of the power transmission system.

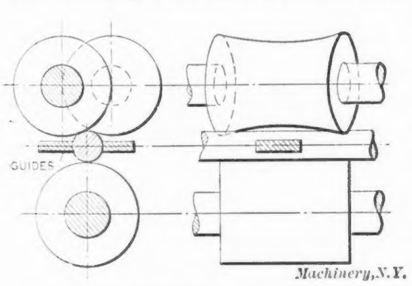


Fig. 2. Straightening Rollers for Shafting.

The objections stated to shafting as ordinarily produced seem to call for a better method of straightening and turning. This is supplied by the straightening process, described below, and by the machine shown in Fig. 1. The shaft is first mechanically straightened, and then turned, or rather hollow milled, and finally tested and polished. The straightening is accomplished by straightening rollers, as shown in Fig. 2. These rollers are mounted with their axes at a slight angle with each other. One of the rollers is concave on its face, while the other has a straight, cylindrical surface, the latter roller being placed in line with the shaft to be straightened, while the concave roller is placed at an angle with the axis of the shaft. When the shaft passes between the rollers, it is guided on the sides by the guides, as shown in Fig. 2. The rollers are provided with adjustment, so that different sizes of shafts may be straightened between the same pairs of rollers. The angle to which the upper roller is turned is also adjusted according to the size of the shaft. This process permits a more perfect straightening of the shaft than do other commonly used shaft-straightening devices.

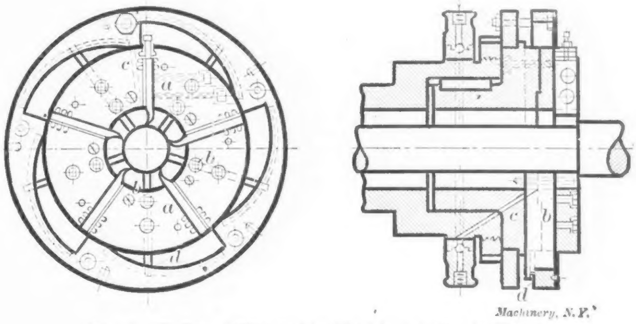


Fig. 3. Hollow Mill used in Machine shown in Fig. 1.

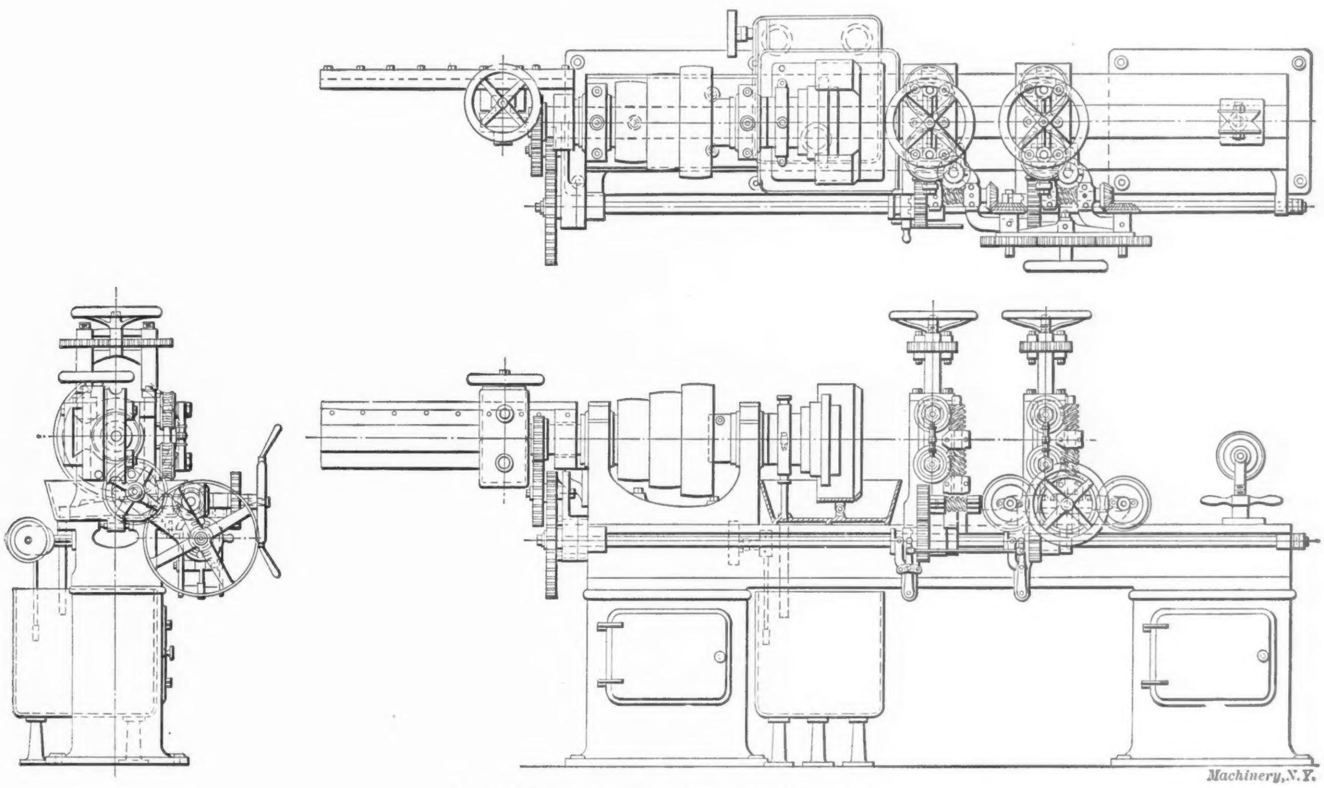


Fig. 1. Machine for Hollow Milling Shafting to Size.

When straightened, the shaft is placed in the machine, Fig. 1, already referred to, and is guided and held centrally with the spindle of the machine by guiding rollers placed in the uprights shown where the carriage usually is placed on the lathe. A hollow mill of special construction, as shown in Fig. 3, is mounted on the end of the hollow spindle. This hollow mill is provided with five adjustable cutters, *a*, and five guides or supports, *b*. These latter are so arranged that they are adjustable to any size of work, within a range of the hollow mill, by means of eccentric cam grooves, *d*, cut in a ring bolted to the body of the mill. The hollow mill is cooled off by water entering into channels in its body. When the shaft has passed through the spindle, it again enters between two guiding rollers, at the left-hand end of the

head-stock of the machine. Guiding the shaft in this manner, by two sets of guide rollers before it enters into the hollow mill, and one set to receive it when having passed through the spindle, keeps the shaft in absolute alignment while the process of hollow milling to size is being performed, and obviates all chance of errors from lack of alignment, or from the springing or bending of the work under its own weight.

The cutting speed of the hollow mill is usually from 70 to 100 feet per minute, and the feed from 5 to 8 inches per minute. This cutting speed and feed make it possible to finish about 30 feet of shafting, 2 inches in diameter, per hour.

SECRECY IN THE ARTS.

Extract from paper by Dr. James Douglas, presented before the American Institute of Mining Engineers, November, 1907.

If it is the fact that technical science has progressed of late with such unwonted speed through the coöperation of many workers, and that this coöperation has been made possible by the publication and exchange of ideas and experiences in the technical and scientific journals, would not our progress be even more rapid and thorough if all barriers of secrecy were broken down, and every encouragement were given to our technical workers to describe, in print and by conference, their notions and their actual experiments? This is the attitude of some, I may almost say of most, of our large concerns, but unfortunately it is not that of all. It is impossible to compare, as to efficiency and profit, works, the gates of which are fast shut, and in which obscurity and secrecy are imposed and practiced, with those to which free admission is granted and in which freedom of information is encouraged. But the following reflections force themselves upon us in this connection. We know that very few technical papers issue from certain establishments; that on their officials silence is imposed; and that to these works inquisitive visitors are politely but peremtorily refused admission. There are not many such, but they are and have been very successful. But suppose that in imitation of their practice and regulations all were tempted to adopt it, so that the same policy became universal; what a sudden paralysis of industry would follow! Our secretaries would find it difficult to fill even their shrunken volumes of transactions with papers worth printing; our students would have to content themselves with the antiquated learning which their professors could supply; for there would be no more summer classes for practical work in mines, smelters and electrical factories, and the professors themselves would have to learn from old books. Every manufacturer and smelter would be obliged to bribe his neighbor's workmen and tempt away his neighbor's superintendents for information. As a result, before long, the very works which now find it so profitable, or think they do, to tap their friends' stock of knowledge and experience, and give nothing in return, would be driven in upon their own resources, and would undoubtedly then find them not so complete as they imagine. Of course, I am supposing an impossibility, because the spirit of intellectual freedom in our professions is too strong and too widespread to submit to such tyranny, and because, before such darkness of ignorance had settled down on our great industries, the most pronounced advocates of secrecy would feel and acknowledge the ultimate consequences of concealment, and would become reformers. To-day they may have secrets, as valuable as Sir Henry Bessemer's method of making plate glass and bronze powder, which it may pay them to conceal from their competitors, so long as they are admitted freely to their competitors' open shops; but even this is doubtful. For the spirit of secrecy is intimately allied with the spirit of suspicion and distrust; and the mind which is always suspecting is closed tight against the admission of fresh and fair impressions. Being jealous of others, it is prejudiced against their suggestions, and correspondingly prejudiced in favor of its own preconceptions. Progress therefore ceases.

This is a temper of mind foreign to a new country like ours, whose special industries have not been established long enough to wear grooves of rigid practice, and sink into ruts of self-satisfied indifference. About the best correction we can apply to the growth of dry-rot is the banishment of secrecy. A curious instance of its blighting influence is seen in some of the older, not the newer, industries of the old world. The iron and steel works of Europe have not kept pace with ours in size and production, but the ironmasters of Great Britain and Germany, in coke-making and in blast-furnace economies and in steel-making processes, have been our teachers. Nor have they been shy of communicating their improvements, or, through jealousy of our success, slow in adopting ours. No nobler monument of international comity in thought and experience exists than in the seventy volumes of the *Proceedings of the Iron and Steel Institute;* and with few exceptions the iron and steel works of England, Scotland, Germany, and France are open to any accredited worker in the same domain. Yet before England was conspicuous as a maker of iron, she was famous the world over for her copper and tin production. But, between self-conceit and the inbred habits of trade secrecy, her copper-smelting industry has fallen from its high estate. And it is not accidental, but linked as closely as any effect with its cause, that this decline is in great part the result of habits of secrecy which grew with the growth of age. At Swansea, every gate to the smelting works is guarded, and as a result it has been as difficult for thought to escape out as for suggestions to find their way in. Swansea should still enjoy the leadership which her skilled labor, splendid coal and commanding maritime situation put within her reach; but she has preferred to gloat over her secrets behind closed doors rather than go out into the world in search of new business as well as technical methods, while also inviting the world to enter and exchange ideas with her. What is the consequence? New Zealand copper comes here to be refined, notwithstanding that the first practical application of electrolysis to metals was made by Elkinton in England, and the Vivians adopted the Manhès method before Farrel introduced it into this country.

There are, however, of course, exceptions in England to this too prevalent habit of secrecy. To the works of the Rio Tinto at Port Talbot or of the Cape Copper Co. at Briton Ferry in South Wales, where metallurgical novelties have been tried, introductions are not refused. But the alliance of decay and suspicion in the instance I have given can hardly be accidental; and we may be sure that what is baneful in its effects in Europe is not likely to be beneficial here; for while the Atlantic separates continents it does not delimit the operation of laws.

In political life, vitality is maintained only when every man takes his full share as a debater in the discussion of political questions, and as a voter in the determination of state affairs. So in scientific and technical matters, the banishment of deceit, mystery and jealousy, and the freest admission of daylight by means of the unreserved diffusion of information through the press and personal intercourse, will instill into the whole body of workers a feeling of healthful rivalry, which, while stimulating their mental activity, will correspondingly benefit the financial interests of their employers.

* * *

Vibration in steamships is probably unavoidable, no matter what means of propulsion are employed. The turbine steamers *Lusitania* and *Mauretania* vibrate considerably in certain parts, much to the disappointment of those passengers who expected to be entirely relieved of this discomfort. The steam turbines, being perfectly balanced, contribute little or nothing to the vibrations, but the propelling screws and the action of the waves, which are also important sources of vibration, have to be reckoned with. The steel hull is a highly flexible and elastic structure which responds to every exterior and interior impulse. Even if it were made of one solid mass of steel, the elasticity and flexibility of a structure 790 feet long would still be very appreciable. The possible extensibility of a steel bar 790 feet long when subjected to a stress of 30,000 pounds per square inch is about 9½ inches, taking the modulus of elasticity as 30,000,000. The hull of an ocean steamer is, of course, much more extensible proportionally than a solid steel bar because of the shape and unavoidable looseness of structure. A small fraction of the possible relative motion of the parts of such a structure repeated many times a minute is quite enough to produce a very disagreeable effect.

MAKING THREAD GAGES.*

A. L. MONRAD.†

The method of making thread gages, described in the following, may not be new, but it has very lately come under the observation of the writer. It seems to be the general idea that screw plug gages must be made of tool steel, but it has been found very practical to make them of cold rolled stock, which is very soft and easy to cut, but which, when hardened, gives a surface which is fully as hard as tool steel. This hard surface extends deep enough into the thread gage to permit grinding 0.005 inch deep, enough hard surface still remaining to prevent rapid wear when in use. Another reason for using this soft steel is also that it is not likely to change its shape, after having been finished, the same as does even the best tool steel, if it has not been properly seasoned after hardening.

For setting a thread tool for cutting a correct thread, a cylindrical thread gage is made, as shown in Fig. 3. This

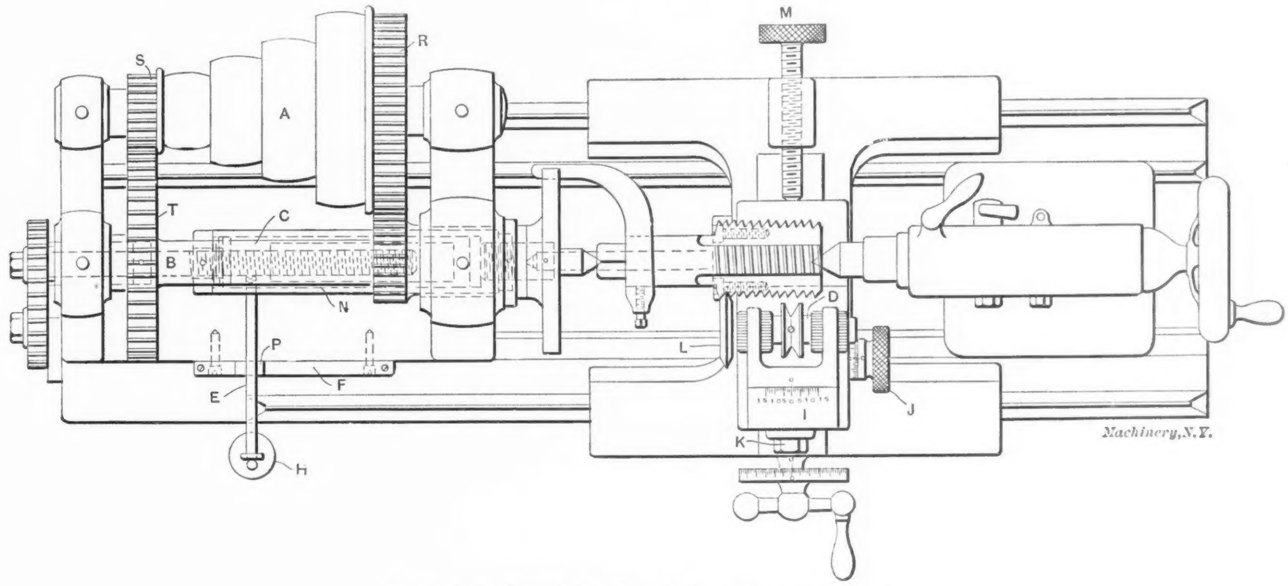


Fig. 1. Lathe for Grinding Taps in the Angle of the Thread.

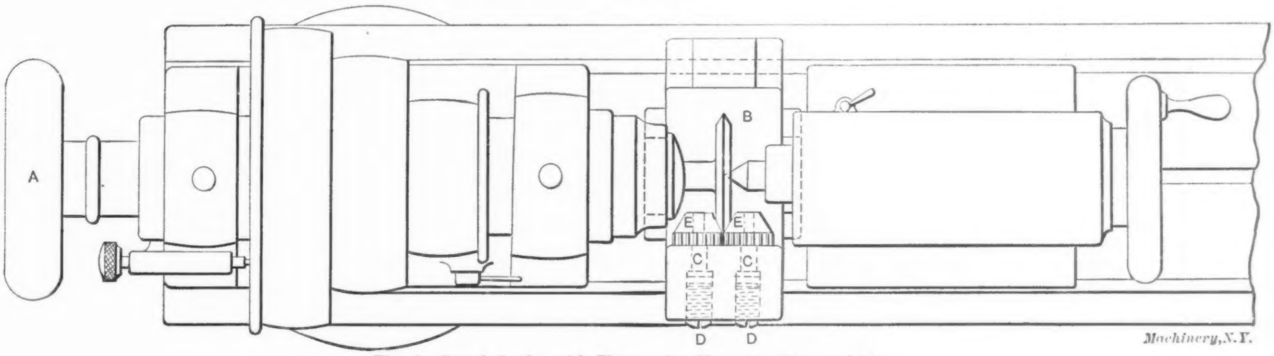


Fig. 2. Bench Lathe with Fixture for Charging Diamond Lap.

thread gage has the advantage over the ordinary thread gage on the market, that it can be placed between the centers of the lathe, and consequently one does not depend upon any secondary surface, against which to set the thread gage. This is the case with the ordinary thread gages, which have to be lined up either against the side of the face-plate of the lathe, or against the side of the work, and in this way small errors are almost always introduced. The thread gage in Fig. 3 is made of machine steel, hardened and ground all over. The main body, *A*, is provided with three grooves, having an inclusive angle of 29, 55, and 60 degrees, respectively, to correspond with the Acme, Whitworth and United States Standard threads, respectively. When the gage is hardened, the grooves are ground with the same setting of the slide-rest, the piece *A* being reversed on the lathe centers while grinding. This insures that both sides of the angle in the gage make the same angle with the axis of the gage.

In one end of the body *A* a hole is drilled, and ground until the bottom of the hole comes exactly in line with the axis, or center line of the body *A*. A hardened and lapped plug *B* is inserted into this hole and held with a set-screw, having a brass shoe at the end. The purpose of this plug *B* is to afford a means for setting the thread tool in the lathe at the correct height, or, which is the same, exactly in line with the axis of the spindle. This is done by merely loosening the clamp which holds the thread tool in its holder, then with the thumb of the left hand on the plug *B*, and the forefinger on the thread tool, it is brought instantly in position, so that the upper face of the thread tool touches the lower side of the plug *B*, as shown in the end view of Fig. 3. When in this position, the clamp of the thread tool holder is again tightened, and the tool is now placed in the correct position as to height. This is the best way of setting the thread tool to the same height as the axis of the lathe centers. [This method of setting of the thread tool to height does not necessarily, however, insure that the thread tool in all cases will be set absolutely correct. If the thread tool holder should be tipped somewhat out of the horizontal position, the top of the thread tool itself would not be horizontal, and consequently, when the gage pin *B* was brought down upon the top of the thread tool, so that the top face would lie perfectly in line with the lower face of gage pin *B*, this pin would not be fully horizontal, and the thread tool would not be set to the exact height of the lathe centers.—EDITOR.]

With the gage remaining between the lathe centers, the angle of the thread tool is set to a correct central position, sideways. This setting is also a check on the accuracy of the angle of the thread tool. A piece of white paper should be used under the gage and the tool, and a magnifying glass should be employed. First, when the tool fits the gage so that all light is shut off, the setting and the angle may be considered satisfactory. The thread tool being set, we are now ready to proceed to finish thread our screw plug gage, which has previously been roughed out by a chaser having three or four teeth, leaving about 0.005 inch for the finishing single point thread tool. The finishing of the thread is continued

* For additional information on kindred subjects, see the following articles previously published in MACHINERY: Measuring Screw Thread Diameters, September, 1907; Tools and Methods for Accurate Thread Cutting, July, 1903.

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until 0.0015 inch is left for lapping. The chaser, as well as the single point tool, should have a clearance of 15 degrees on the front face of the thread tool. This angle has proved to be the most advantageous for all practical purposes.

After having been finish threaded, the screw plug is casehardened and ready for lapping. A lap made as shown in Fig. 4 is used. It will be seen that this lap is somewhat different from those ordinarily used for this work. The con-

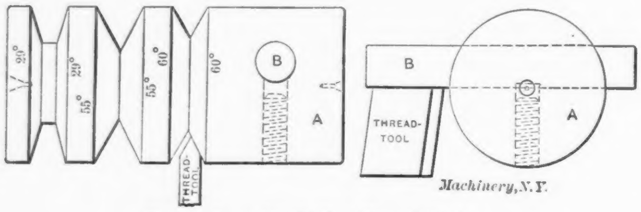


Fig. 3. Gage for Setting Thread Tools.

struction shown has been adopted because of the difficulty met with in circular laps which are split on one side for adjustment, but have nothing on the sides to hold the two sections in perfect alignment. Consequently, each of the sides has a tendency to follow the lead of the screw plug when lapping, and difficulty is experienced in getting a thread with perfect lead. The lap here shown, therefore, has a dowel pin *A* on each side for the purpose of holding the two sections in perfect alignment, and the adjusting screws *C* are inserted outside of the dowel pins. The two screws *B*, finally, clamp the two halves together. When the lap is assembled and screwed together, it is roughed out in the lathe with a threading tool, or tapped with three or four different sized taps, following one another in proper rotation. The lap is then taken apart, and planed on the inside to permit of adjustment; three grooves are cut in the thread on each side of the lap, for holding reserves of emery and oil. This will permit constant lubrication of the lap, and constant charging when lapping the screw plug to size. The lap is finished with a master tap, which must be made with extreme accuracy. This

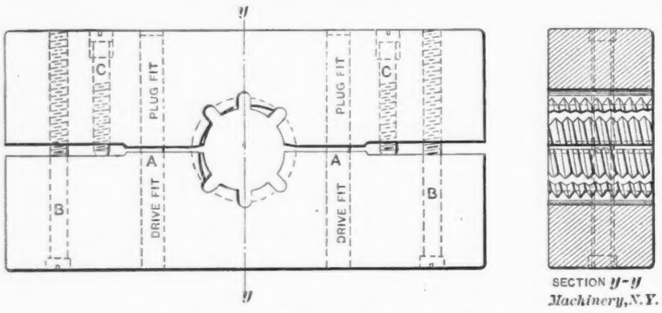


Fig. 4. Lap for Screw Plug Gages.

tap is ground in the angle of the thread, as shown in Fig. 1, and it is finished to a dimension 0.002 inch below the size diameter of the thread plug to be made, in order to permit the lap to wear down to the size when lapping.

The lathe must be revolved very slowly when grinding the master tap, the revolutions of the spindle being from 20 to 100 per minute, according to the size of the tap. As will be seen in the cut, the cone pulley is placed where the back gears ordinarily are located. Gear *R* is disconnected, and the drive is through gears *S* and *T*. The reason for having the cone pulley in the back, is because it is wanted to use the space directly under the usual location of the cone pulley in the center of the lathe for a mechanism intended to permit a slight adjustment of the lead of the tap when grinding in the angle of the thread.

The feed screw *B* is placed in the center of the lathe bed, directly under the driving spindle, and fits into a solid nut, *C*, from which, through the medium of a casing *N* and a connecting-rod, the carriage is moved. A rod *E* is screwed into the nut *C*, this rod extending over the side of the lathe, and resting upon the edge of plate *F*, which can be so adjusted that it inclines from one end to the other from 0 to 20 degrees. Between this plate and the rod *E*, a shoe *P* is placed. On the extreme end of the rod hangs a weight *H* which holds the rod against the plate *F*. This arrangement serves the purpose of giving a slight change in the lead of the tap being ground, as it is evident that when the rod *E* travels along the plate *F*, on the incline upward, it slightly turns the nut and moves it forward a trifle in excess of the regular forward motion imparted to the nut by the motion of the lead screw. By inclining the plate *F* in the other direction, the motion of the nut may be correspondingly retarded.

A grinding fixture *I* fits the slides on the top of the carriage. On the right-hand side of this fixture is placed a knurled handle *J*, graduated to thousandths of an inch. This handle is for the fine adjustment of the fixture, enabling the grinding wheel to be set correctly to the center of the thread, before starting the grinding operation. The top of the fixture swivels in a vertical plane, so that the wheel *L*, which is made of tool steel and charged with diamond dust, can be set at an angle to the vertical, either to the right or the left, according to the pitch and direction of the thread. This adjustment is made by loosening the nut *K* which binds the head in position when set to the correct angle. The wheel *L* is provided with a shank which fits a tapered hole in the

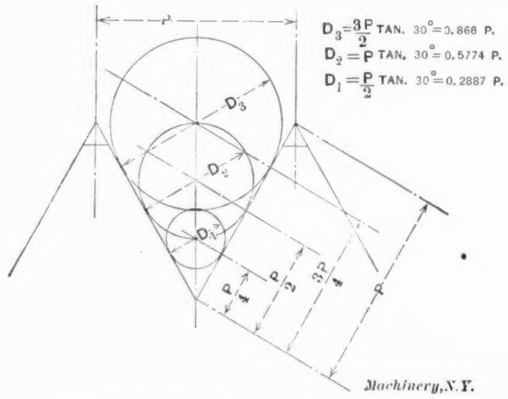


Fig. 5. Formulas and Diagram for Determining Ball Points for U. S. Standard and V-threads.

spindle *D*, which latter runs at a speed of 20,000 revolutions per minute. A solid backstop *M* is provided to hold the fixture securely in place while working. The lathe spindle, with the tap, and the grinding spindle run in the same direction, the same as in an ordinary grinder.

A good supply of sperm oil should be used when grinding the tap, and it is necessary to have a cover over the wheel, to prevent the throwing out of oil. This cover, however, is not shown in the cut. Care should be taken not to force the wheel into the work, as if that is done, the shape will soon be destroyed. The wheel should just barely touch the work, and should be fed in a very small amount, say, 0.00025 inch at a time. A sound magnifier or listener should be used, to hear whether the wheel is cutting moderately.

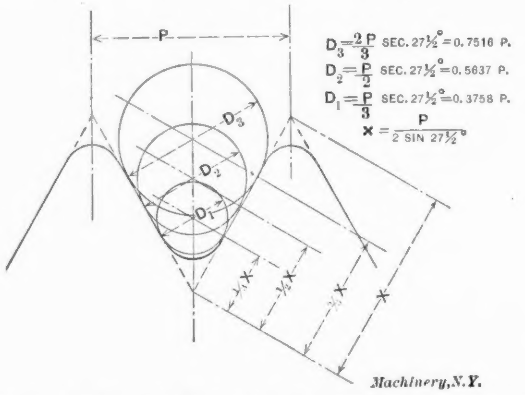


Fig. 6. Formulas and Diagram for Determining Ball Points for Whitworth Standard Thread.

The wheel is charged in the following manner. A chuck, with a tapered hole which fits the shank of the diamond wheel, is placed in the spindle of the bench lathe, as shown in Fig. 2, and the tail-stock center is pushed up at the other end to get a good support when charging. Fixture *B* is placed in the bench lathe, and clamped with a bolt and nut from underneath the lathe, about the same as an ordinary slide-rest. The front end of the fixture extends up vertically

above the center of the spindle. In this projecting part, two holes are drilled, reamed, and counterbored, at the same height as the center of the lathe spindle. In these holes are fitted two studs *C C* having a T-head inside the counterbored hole. Between the T-heads of these studs and the screws *D D* lie

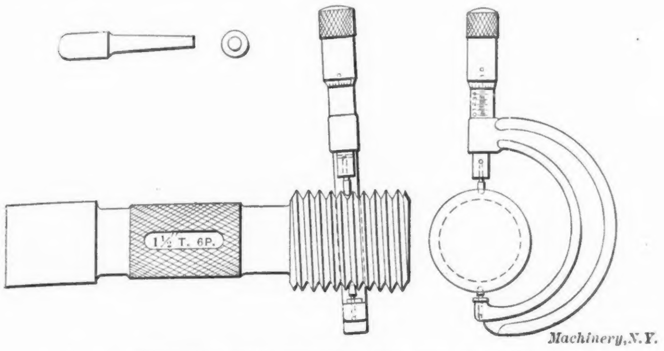


Fig. 7. Comparing Angle Diameters with Ball Point Micrometer.

fiber washers, which act as friction stops. On the other end of plugs *C C* are placed hardened and ground rollers *E E* having one end beveled to a 30-degree angle, while the other end has spur gear teeth milled, which mesh into each other. With the slowest speed of the bench lathe, the fixture is fed in by hand, and having two slides at right angles to each other, the same as an ordinary slide-rest, it can be located to the proper position without much trouble. A piece of soft steel wire should be flattened out to make a spade, with which to take up the diamond dust for charging the wheel. One should not try to use a piece of wood, or a brush, as that will only be a waste of diamond. The master tap, which is to be ground, is relieved up to within 1/16 inch from its cutting edge with a file, this being done in order to prevent any more grinding than is absolutely necessary, and to permit the tap to cut freely. The length of the threaded part of the master tap should be about two times its diameter.

The master tap being finished, the lap for the screw plug gages, Fig. 4, is tapped, and ready for use. When charging this thread lap, great care should be taken not to force the lap too much. The spindle of the lathe, where the lapping is done, should be run very slowly, with the back gears in, until the lap is thoroughly charged with emery mixed with sperm oil. Then the lathe may be speeded up to a higher speed, according to the size of the screw plug. It is poor practice to use too much emery on the lap. Reverse the lap often, and use it the same amount on either side. If a large number of screw plugs are to be lapped, all of the same size, lap them all, one at a time, with the lap at the same setting. In this way the lap keeps its shape better, and can be used a long while before being retapped. Do not attempt to tap the lap with the master tap when charged with emery, but use a roughing tap first, and also wash out the lap in benzine before tapping. When the screw plug has been lapped to within 0.0005 inch of its size, it is ground on its outer diameter, if it be a U. S. Standard thread plug, and then finished by lapping after being ground. This will permit the top corners to be kept sharp, and better results will be obtained all around.

Great care must be exercised during the lapping operation to see that the angle of the thread is correct. The gaging of the angle of the thread is accomplished in the following manner. Three micrometers are used to measure the correct angle. Two ball points of the same size are placed in tapered holes in each micrometer, as shown in Fig. 7. These ball points are ground all over, and made to a shape as shown in the upper left-hand corner in Fig. 7. The body of these ball points is ground parallel, and then the end is turned and ground to a ball shape as shown. Three sets of ball points are used for each pitch, one to measure the thread near its bottom, one at the center, and one near the top, as indicated in Figs. 5 and 6. The master screw plug is used for comparison; one micrometer is set to the master screw plug at the bottom of the thread, in the manner indicated in Fig. 7, and is then tried on the thread plug being made. The difference in diameter between the measured diameter on the master gage, and that on the plug being made, is noted. Then the two other micrometers, measuring at the center and near the top of the thread, are used, and the difference between the master gage and the screw plug diameters at the places where these micrometers measure, is also noted. If all three micrometers show the same amount of difference in relation to the master plug, then the angle of the thread evidently must be correct. After that, the micrometer measuring at the center of the thread is used to measure the size of the screw plug, comparing it with that of the master gage, until the plug is finished to size.

Figs. 5 and 6 show how formulas are derived for the size of the ball points used in measuring. Fig. 5 applies to a

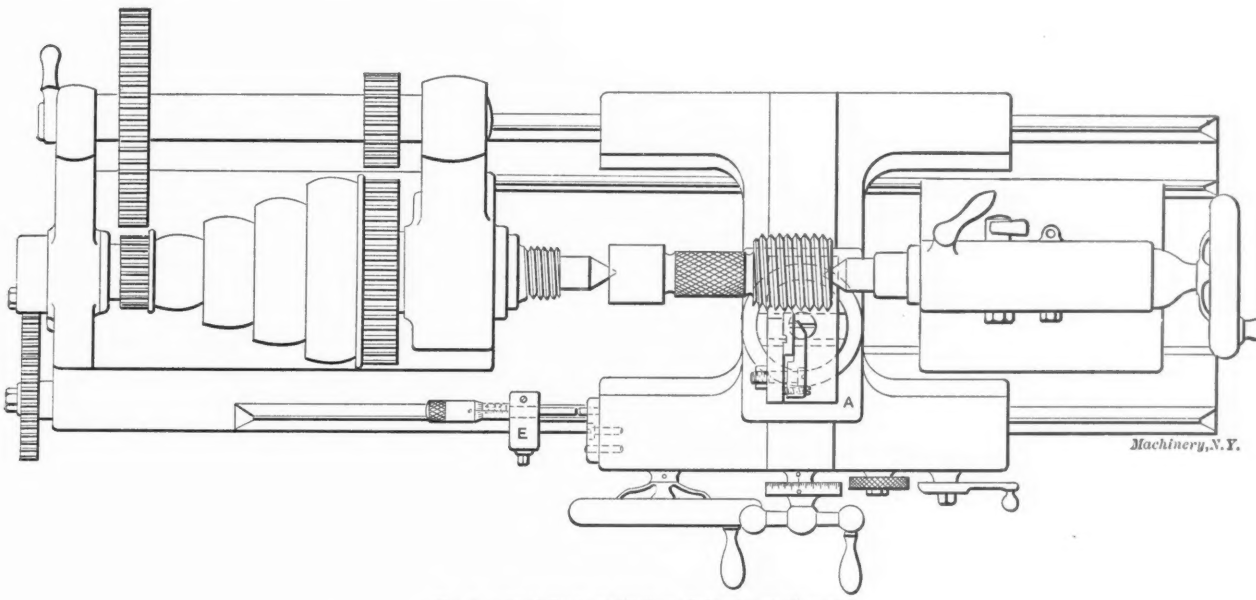


Fig. 8. Final Test of Pitch and Angle of Thread.

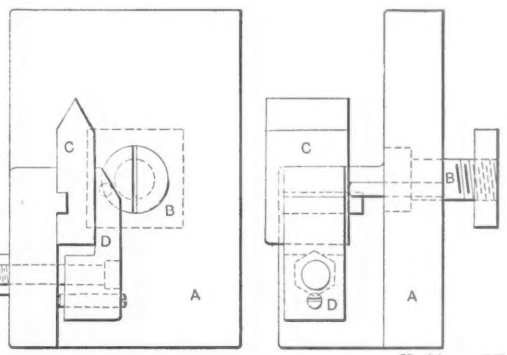


Fig. 9. Gage for Testing the Angle of the Thread.

60-degree thread, either sharp V or U. S. Standard, while Fig. 6 gives the formulas for a Whitworth thread. The diameters D_1, D_2, and D_3, respectively, are the diameters of the cylindrical portions of the ball points used, and are, of course, also the diameters of the half-spheres on the end of the ball points. Tables I and II give these diameters for a number of different pitches, figured approximately from the formulas.

For testing the angle of the screw plug, when finally finished to a limit of 0.0005 inch, it is tried in a testing machine, such as shown in Fig. 8. This machine is simply an ordinary lathe, fitted with a fixture *A*, shown separately in Fig. 9. The tool-post is taken off the lathe, and replaced with this fixture, which is clamped in the T-slot of the tool-post slide, with bolt *B*, Fig. 9. The thread gage *C* is ground all over, and the angle fitted to a master gage. The gage *C* is held by the tongue and groove on the left-hand side of the fixture, and clamped with a strap *D*. To set this gage correctly, in relation to the axis of the spindle of the lathe, as regards height as well as angle, the angle gage, Fig. 3, is used in the same way as has been previously explained in relation to thread cutting. When the fixture has been placed correctly in position, the screw plug is inspected by placing the gage with the hand first to the right and then to the left side of the thread angle. A strong magnifying glass is used with a white paper underneath, and any imperfection of the angle is easily detected, and can be corrected, when lapping the last 0.0005 inch to size. If the test gage shows an opening either at the bottom or at the top, the fault is that the lap is worn and must be retapped, or it may be that too much emery has been used. If, for some reason or other, it is impossible to correct the screw plug within 0.0001 inch, when lapping, take a piece of hard wood, or flatten a piece of copper wire, charge it with emery, and hand lap the high points of the angle, while the screw plug is revolving slowly in the lathe. In this way, it is comparatively easy to overcome this trouble, but great care must be taken to follow the thread properly with the hand lap.

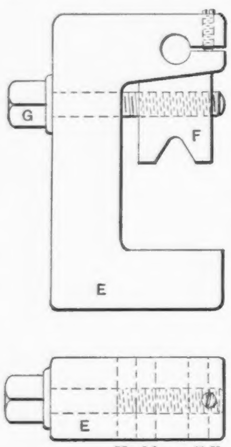


Fig. 10. Holder for Micrometer Stop.

TABLE I. BALL DIAMETERS TO BE USED IN DETERMINING CORRECT ANGLE OF THREAD FOR V, U. S. S. AND BRIGGS STANDARD THREADS.

Threads per inch.	D_3	D_2	D_1
32	0.028	0.018	0.010
28	0.030	0.020	0.010
24	0.035	0.024	0.012
22	0.040	0.026	0.014
20	0.045	0.028	0.014
18	0.050	0.030	0.016
16	0.055	0.035	0.018
14	0 060	0.040	0.020
13	0.065	0.045	0.022
12	0.070	0.050	0.024
11	0.080	0.055	0.026
10	0.085	0.060	0 030
9	0.095	0.065	0.030
8	0.100	0.070	0.035
7	0.120	0.080	0.040
6	0.140	0.095	0.050
5½	0.160	0.110	0.050
5	0.170	0.120	0.060
4½	0.190	0.130	0.065
4	0.220	0.140	0.075
3½	0.240	0.170	0.085
3	0.280	0.190	0.095
2⅞	0.300	0.200	0.100
2¾	0.320	0.220	0.100
2⅝	0.320	0.220	0.110
2½	0.340	0.240	0.110
2⅜	0.360	0.240	0.120
2¼	0.380	0.260	0.130

To find if a screw thread has a perfect lead, the micrometer stop *E*, Fig. 8, is placed on the left-hand side of the carriage. The holder for this micrometer stop is shown separately in Fig. 10. The construction of this stop is very simple. The micrometer head is an ordinary one, as made for the trade by manufacturers of these instruments. The holder *E* is made similar to a C-clamp, with a hole drilled and reamed to fit the micrometer head. A slot is sawed through the upper jaw, with a stop screw on the top, which prevents the micrometer from being clamped too hard in the holder, in which case the thimble would not revolve freely. Underneath this hole the holder is beveled off, and a V-block *F* is held in position by a screw *G*, entering from the side. The micrometer head is placed in the hole provided for it, with its division reading faced upwards, and the screw *G* clamps the micrometer head and the holder *E* at the same time. When the lead of the screw plug is tested, the carriage is moved one inch along the thread. It is understood that the lead screw of the lathe is not employed in this case, but one depends upon the micrometer for measuring the correct lead of the screw plug.

TABLE II. BALL DIAMETERS TO BE USED IN DETERMINING CORRECT ANGLE OF THREAD, WHITWORTH STANDARD THREAD.

Threads per inch.	D_3	D_2	D_1
32	0.024	0.018	0.012
28	0.026	0.020	0.014
24	0.030	0.024	0.016
22	0.035	0.026	0.018
20	0.040	0.028	0.018
18	0.040	0.030	0.020
16	0.045	0.035	0.024
14	0.055	0.040	0 026
13	0.060	0.045	0.028
12	0.065	0.045	0.030
11	0.070	0.050	0.035
10	0.075	0.055	0.035
9	0.085	0.060	0.040
8	0.095	0.070	0.045
7	0.110	0.080	0.055
6	0.130	0.095	0.060
5½	0.140	0.100	0.070
5	0.150	0.110	0.075
4½	0.170	0.120	0.085
4	0.190	0 140	0.095
3½	0.220	0.160	0.110
3	0.260	0.190	0.120
2⅞	0.260	0.200	0.130
2¾	0.280	0.200	0.140
2⅝	0.280	0.220	0.140
2½	0.300	0.220	0.150
2⅜	0.320	0.240	0.160
2¼	0.340	0.260	0.170

The master plug may, of course, also be placed between the centers and comparison be made with the master plug. In this case, the micrometer serves as a comparator. A plate is screwed on the left-hand side of the carriage, provided with a hardened stop against which the end of the micrometer screw bears. It is evident that the carriage must not be moved against the micrometer with too much force, but simply brought up to barely touch against the end of the micrometer screw.

* * *

The tables in the data sheet for January, 1908, by Mr. Joseph Holveck, giving the horse-power transmitted by cast iron and raw hide pinions, are for 1 inch width face, only. For wider faced pinions, multiply the values given in the tables by the width of face in inches.

* * *

Bids were opened by the city of Atlanta on November 25 for one 20,000,000-gallon vertical triple-expansion crank-and-fly-wheel pumping engine with a guaranteed duty of not less than 170,000,000 foot-pounds per 1,000 pounds of dry steam. The following bids were tendered:

Allis Chalmers Company	60-inch stroke	$134,000
Allis Chalmers Company	66 " "	149,300
Bethlehem Steel Company	66 " "	132,000
Camden Iron Works (R. D. Wood & Co.)	66 " "	147,700
Holly Mfg. Co.	66 " "	156,000
William Tod Co.	66 " "	157,400
William Tod Co. (same pump with special terms of payment)		165,000
Wisconsin Engine Co.	60 " "	139,500

The latter company was awarded the contract.

FINISHING GAS ENGINE FLY-WHEELS ON THE GISHOLT TURRET LATHE.

We believe that the following description and the accompanying line engravings will have suggestive value to mechanics interested in the making of automobile or other gas engines, as well as to others who have turret lathe work of a similar character to do.

Operation for Finishing a Fly-wheel at One Setting.

Fig. 1 shows an arrangement of tools by means of which it is possible to finish a fly-wheel complete at one setting. The hole for the shaft has to be bored and reamed, the hub has to be faced on both sides, and the sides and periphery of the rim are to be finished, all four corners of the rim being rounded. The outfit of tools shown is designed to accomplish this. It consists of boring bars, reamer and facing heads in the main turret, a turret tool-post on the slide rest (carrying in this case three tools) and a special supplementary wing rest attached to the front of the carriage at the extreme left.

The work is held by three special hardened jaws B in a universal chuck. These grip the work on the inner side of the rim, leaving room for a tool to finish the rear face without striking the chuck body or the jaws. Three rests C are provided between the chuck jaws; the work is pressed against these while it is being tightened in the chuck, and they serve to locate it so that the arms will run true so far as sidewise movement is concerned, and so that the work will be properly placed with relation to the stops for the turret and carriage movements. The chuck carries a bushing R of suitable diameter to support boring bars in the main turret, as will be described.

In the first operation, boring bar M is brought in line with the spindle and entered in bushing R in the chuck. Double-ended cutter N is then fed through the hub of the pulley to true up the cored hole. While boring the hole, the scale on the front face of the rim and the hub is removed by tool J. Tool K is then brought into action to rough turn the periphery, after which tool E, in the wing rest, is fed down to clean up the back face of the rim. As soon as the scale is removed, the hole is bored nearly to size by cutter N_1 in bar M_1, and finally finished with reamer Q, mounted on the floating arbor.

Next, cutters F, G, and H, in the facing head, are brought up to rough face the hub and rim, and round the corners of the latter on the front side. This operation is all done by broad shaving cuts. The facing head in which the tools are held is provided with a pilot bar T which fits the finished hole in the work, and steadies the head during the operation. The various cutters F, G, and H, are mounted in holders which may be so adjusted as to bring them to the proper setting for the desired dimensions. This finishes the roughing operations.

The periphery of the rim is now finished by cutter L in the turret tool-post, which is brought to the proper position for this operation. The rear face of the rim is finished by tool E, the same one with which the roughing is done. E is removed and replaced with D which rounds the inner corner of the rim. This is in turn replaced with a third tool for rounding the outer corner of the back side. For finishing the front faces of the rim and hub and rounding the corners of the former, a second facing head, identical with the first one, is employed. This is shown in position in the engraving. Blades F_1, G_1, and H_1, correspond with the blades F, G, and H, previously referred to, and perform the same functions.

The only remaining operation, the finishing of the back of the hub, is effected by cutter P. This cutter is removed from the bar, which is then inserted through the bore and the cutter replaced in its slot, when the rear end of the hub is faced by pressure on the carriage away from the head-stock. This completes the operation required for finishing the wheel complete at one setting.

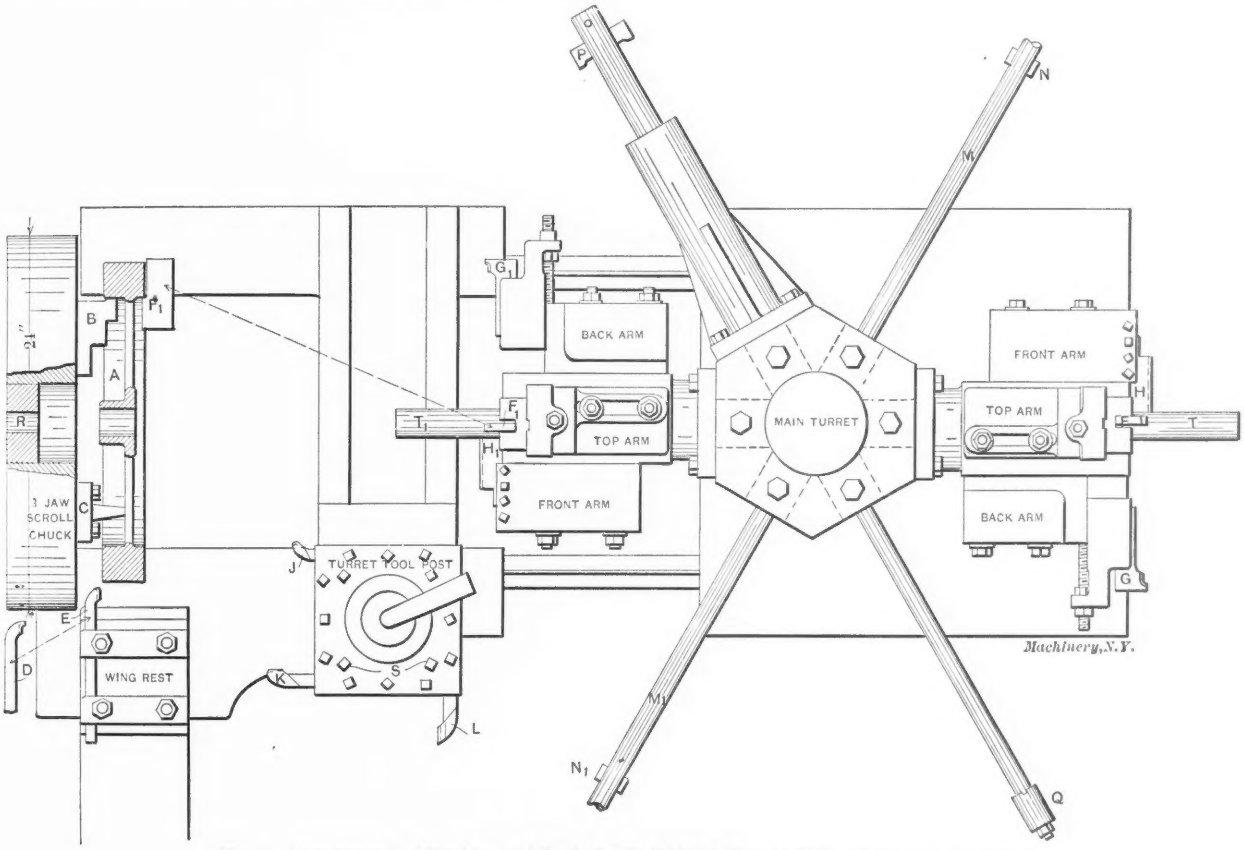


Fig. 1. Arrangement of Machine and Tools for Finishing a Fly-wheel Complete at One Operation.

Finishing a Webbed Fly-wheel All Over in Two Settings.

In Figs. 2 and 3 are shown the arrangement of tools for finishing a webbed fly-wheel which has to be machined all over. This, of course, requires two operations. In the first of these, Fig. 2, the rough casting is chucked at A on the inside of the rim with regular inside hard chuck jaws B.

The engraving shows the first operation in progress. The cored hole is being rough bored with cutter N supported in the end of boring bar M, and guided by the drill support D pivoted to the carriage. Next, the boring bar M_1 is brought into position, the drill support being thrown back out of the way. This bar is steadied by its bearing in bushing R in the chuck, the same as provided in the case of Fig. 1. Two cutters, N_1 and N_2, are used to roughly shape the hole to the desired taper, the small end being finished to within 0.002 of the finished size. While boring with the bar M_1, the scale is broken on the web and hub of the piece with the tool K in

the turret tool-post. The latter is then shifted to bring the tool J into position for removing the scale on the periphery of the wheel. Next, the hole is reamed with taper reamer Q, the pilot of which is supported by bushing R.

with the soft slip jaws B, which are bored to the exact diameter of the piece. The work is further supported and centralized by sliding bushing C, which is tapered to fit the finished hole in the work, and has an accurate bearing in bushing R in the chuck as well. As shown, it is provided with a threaded collar for forcing it into the work and withdrawing it.

First, the scale on the web and the inside and face of the rim is broken with the tool K in the turret tool-post. These surfaces are then roughed off with cutters F, G, and H, in the facing head. This latter is steadied by a pilot T which enters the hole in the sliding bushing C on which the work is supported. This brings the piece approximately to size. Next, a light cut is taken with blades F_1, G_1, and H_1, in the finishing facing head, which completes the operation.

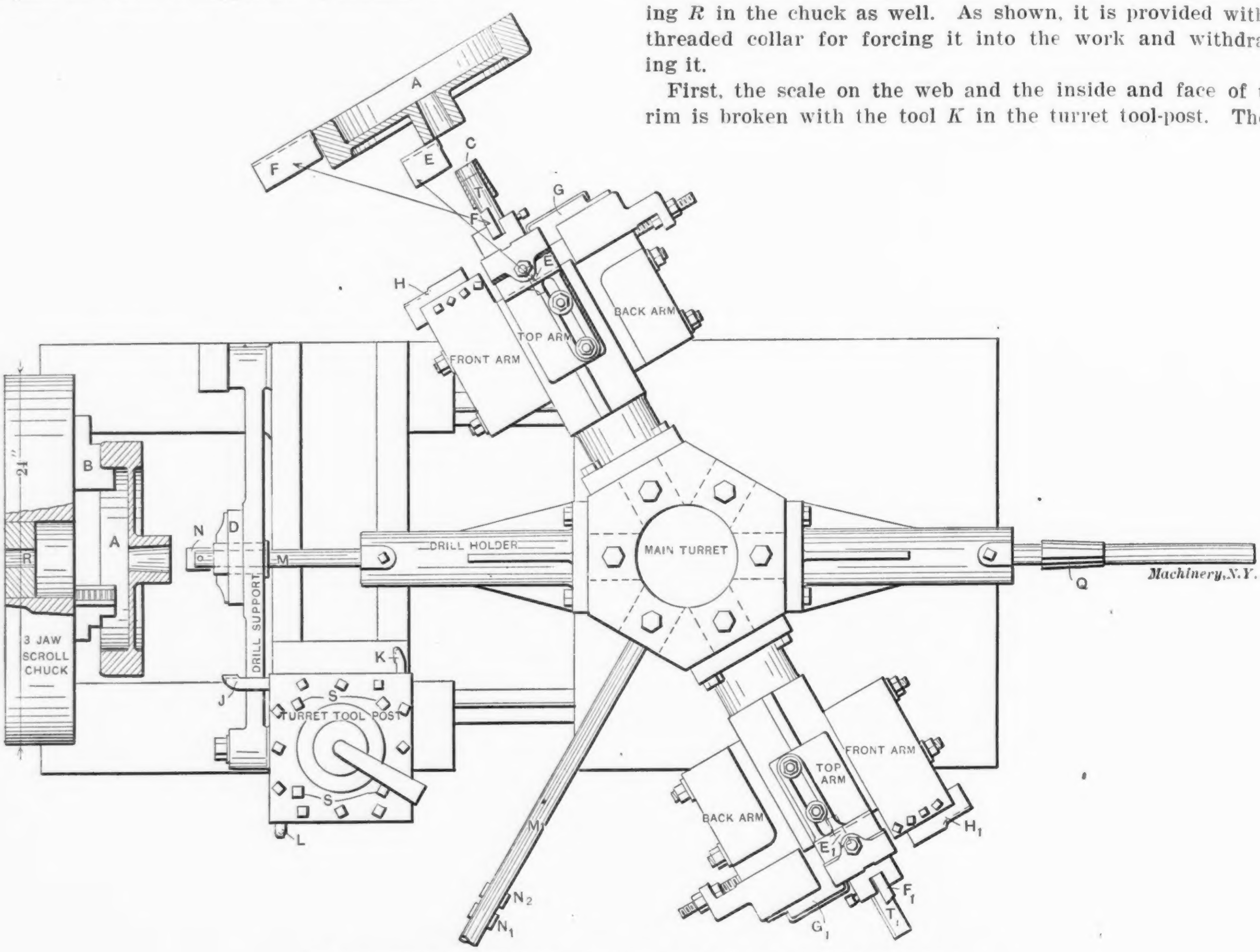


Fig. 2. Finishing the Periphery, Front Face, and Bore of a Webbed Fly-wheel.

The first of the facing heads is now brought into action. This facing head carries a guide T which is steadied in a taper bushing C, driven into the taper hole of the work for that purpose. Blade F turns the periphery, blade G turns the hub and faces the web, and blade H faces the rim. A fourth blade E on the under side of the head faces the hub. This brings the piece approximately to size. For finishing, the similar cutters E_1, F_1, G_1, and H_1, in the other facing head are used, this latter being supported by the taper bushing C in the same way. Only a very light cut is taken for finishing. Tool L in the carriage turret is then used to round the outer and inner corners of the rim, this completing the work on this face of the casting.

In the second set of operations, shown in Fig. 3, the same piece, reversed, is shown chucked on the outside diameter

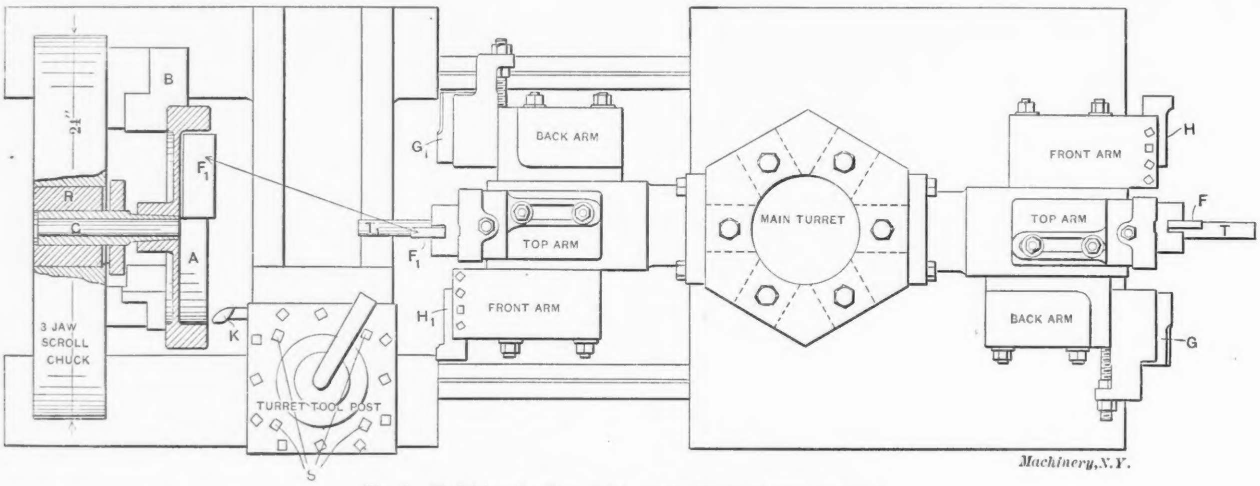


Fig. 3. Finishing the Rear Face of the Work shown in Fig. 2.

The tools and operations shown represent the practice of the Gisholt Machine Co., 1316 Washington Ave., Madison, Wis.

* * *

The construction of a lighthouse at the Ar-Gazeck reef near Ushant on the French coast, is being conducted under great difficulties owing to the swiftness of the currents which prevented more than 52 hours' work on the foundation during 1904, more than 206 hours in 1905, and more than 152 hours in 1906, making 51 eight-hour days during three years.

LETTERS UPON PRACTICAL SUBJECTS.

A TOGGLE-JOINT PUNCH.

Punch and die work on sheet metal is done principally upon two kinds of punch presses, namely, the single-acting and the double-acting press. The kind of press to be used depends upon the nature of the work to be done. The single-acting press has one eccentric, or crank, on the shaft, which transmits the required motion to the punch; while the double-acting has two eccentrics, or cranks, set in such a relation to each other that there is produced a follow-up motion. The punch is attached to one eccentric arm, or connecting-rod, and another punch or plunger to the other arm, or connecting-rod. The plunger works on the inside of the punch, and is generally used to form the metal into some desired shape after the blank is cut out. The plunger comes into action just after the punch has cut the blank. By means of the double-acting press, the work is punched and formed in one stroke, and in some classes of work, it is pushed through the die and falls into a box under the press. The single-acting press will do the same work, but the dies are more complicated, and the work comes up on the die by means of springs, and is

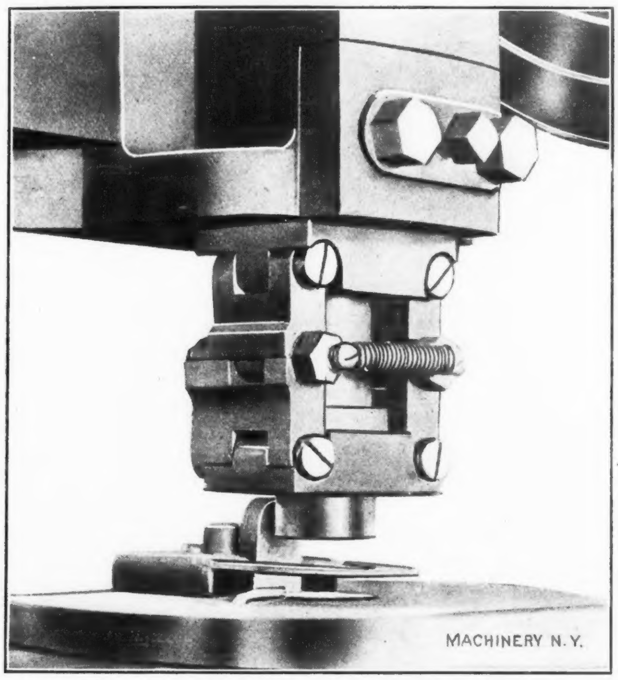


Fig. 1. View showing the Punch in the Up Position.

removed from the die by being brushed off or by sliding off by gravity, since many presses are made so that they can be set in a tilted position. The advantages of the double-acting press are many. The punches and dies are very much more simple and durable than those for the same work on the single-acting press, and the work can be done much more rapidly. Many manufacturers who do their own stamping work purchase the single-acting press, because of lesser first cost over the double-acting press. This is not the most economical method in the long run, if there is a great deal of punching work to do that could best and cheapest be done on a double-acting press.

I shall describe a punch and die which I have designed, which does the work of a double-acting press on a single-acting one. In this design, I have employed the well known toggle-joint. The work of this punch and die is the punching and forming of can bottoms from heavy stock. There are many sizes of cans, and the parts of the punch and die are interchangeable for the different sizes. When the punch is in the up position (Fig. 1), the toggle-joints are in line and are held there rigidly by means of two springs. The punch holder *A* (Fig. 2) is attached to the lower joints of the toggles, and slides up and down on the forming plunger *B*. In operation the punch *C* comes down on the stock and cuts out the circular blank on the die *D*. Just after the blank is cut, the arms *E*, of the lower joints, strike the opening wedge *F* and open the toggle-joints. This causes the punch *C* to slide up on the plunger *B*. Then the plunger *B* continues downward and presses the blank over the rounded shoulder *a*. There is enough clearance between the plunger and the inside of the forming ring, below the shoulder *a*, to allow for the

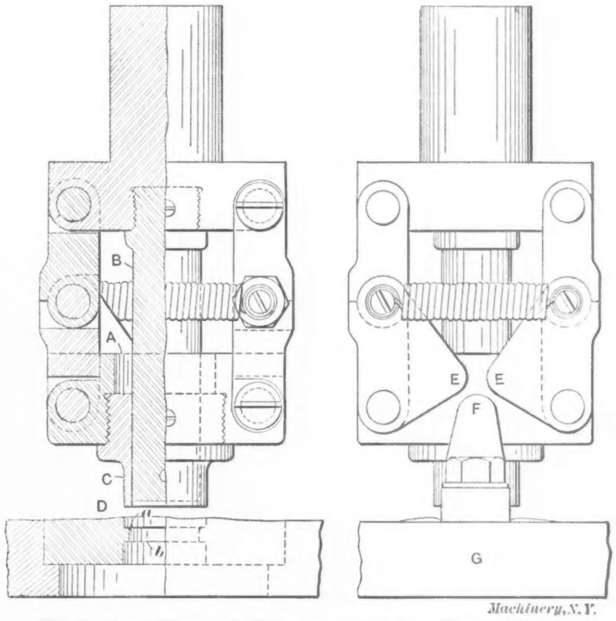


Fig. 2. Front View and Half-section, and Rear View of Punch.

thickness of the metal. After the plunger pushes the formed can bottom through the forming ring at *b*, it starts on the upward stroke. The finished can bottom is stripped off the plunger at the shoulder *b* in the die, and drops into a box under the press. After the arms *E* of the toggle pass above the opening wedge *F*, the toggles close by means of the springs.

It will be noticed that the plunger does not extend flush with the bottom of the punch *C* when the punch is in the

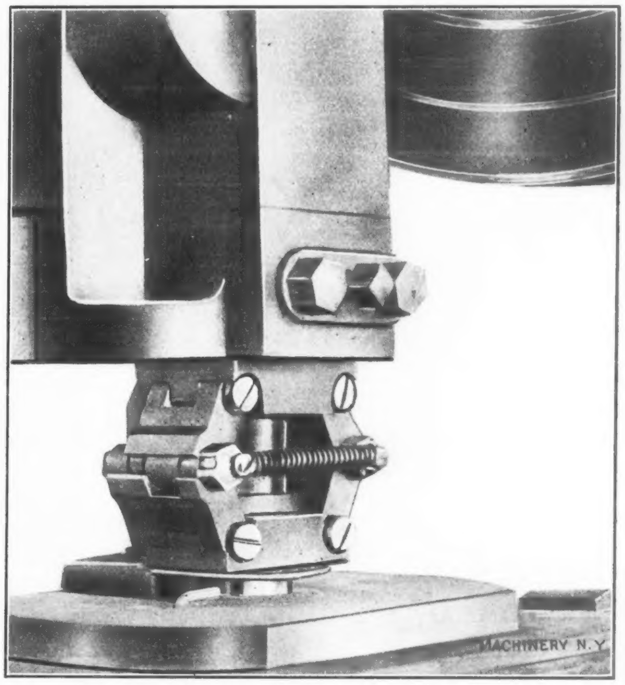


Fig. 3. View showing the Down Position of Punch.

up position. This is for the purpose of allowing the punch to cut the blank before the plunger comes into action. A feature of this punch is that the toggle-joints hold the punch holder perfectly rigid until the blank is cut and the toggles opened. The strain does not come on the bolts, but on the curved shoulders, plainly shown in the isometric views (Fig. 4). If the strain did come on the bolts, there would be a tendency to shear them, especially when cutting heavy stock,

and they would soon be worn enough to throw the whole punch out of true. In this design, there is little wear on the bolts. Figs. 1 and 3 show the up and the down positions of the punch, also the stripper for removing the scrap stock from the punch piece. There is also a stop shown by means of which the holes in the stock are spaced as near together as possible in order to save metal.

This punch will work as fast as the stock can be fed in. There is no trouble caused by bits of metal getting into the die, as there is in dies which throw the finished work up to be brushed off the bolster plate. There is no stopping of the punch to allow the finished work to slide off or be brushed off the bolster plate, as is the case with the old form of punch and die. The opening wedge *F* (Fig. 2) is bolted to the bolster plate *G*, and it is of such a height as to open the toggles just after the blank is cut, and before it is formed. The rubbing surfaces of the wedge and opening arms are case-hardened to prevent wear. The curved shoulders *c* and *d* (Fig. 4) are machined out accurately with an end mill. The punch *C* and the die *D* (Fig. 2) are made of tool steel and hardened. The die is afterwards ground. The cutting edge of the die is waved in order to get a good shearing effect on the stock. The plunger *B* and the punch piece *C* each have a shoulder. These pieces are screwed firmly in their respective holders. There is also a headless set-screw in each holder to prevent any possibility of the piece working loose. When it is desired to change the size of the can bottom, the only parts to be changed are the plunger *B*, the punch piece *C*, and the die *D*. The plunger and the punch are unscrewed with a spanner wrench. Three different sizes of the can bottoms formed with these punches and dies, are shown in Fig. 5.

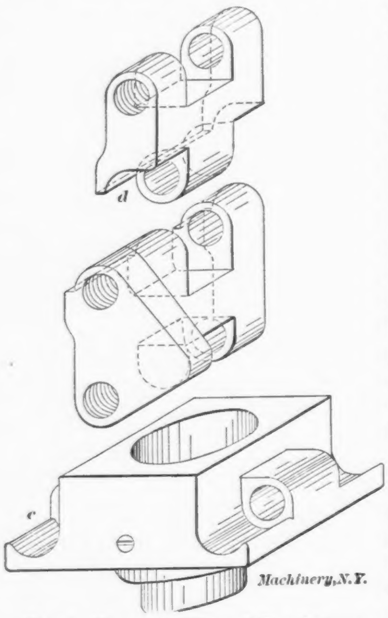


Fig. 4. Isometric View of Toggle-joint and Punch Holder.

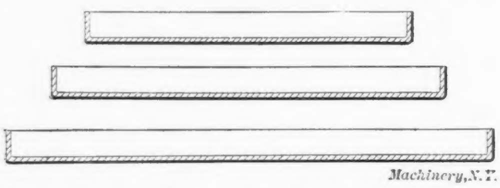


Fig. 5. Can Bottoms which are formed by the Toggle-joint Punch.

This punch and die, after much service, has been found very satisfactory, and has given very little trouble. I have designed a similar punch and die for making square and rectangular can bottoms which has also given satisfaction. Toggle-joint punches can be made for many other purposes, and this type of punch is a time and money saver when used on single-acting presses. J. E. WASHBURN.

Cleveland, O.

SOME GAS ENGINE TROUBLES.

A gas engine had a sparking device arranged as shown in Fig. 1, in which *A* is an insulated point in the sparking plug located in the cylinder head, and *B* a movable point also in the sparking plug but not insulated. This point is driven by a cam on the engine, making and breaking the current to cause the spark. *C* is a spark coil; *D* a battery of four cells; *E* a single-pole double-throw switch, and *F* a small dynamo driven through a friction wheel from the rim of the fly-wheel, and wired up to the other parts as shown. It was customary to throw the switch over to the right and so use the battery current for starting, after which the switch was thrown to the left, and the current taken from the dynamo for the spark. One morning all efforts to start the engine failed, until it was discovered that when the spark plug was held in the hands it would emit a brilliant spark, but if allowed to touch any part of the engine, a very feeble one. A further investigation showed that one of the brush holders

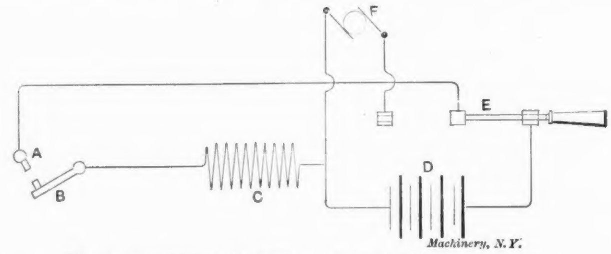


Fig. 1. Diagrammatical View of the Ignition Apparatus.

on the dynamo was grounded, and that the current instead of going through the spark coil *C*, took the easier path up to the dynamo brush, thence to the frame of the dynamo, and then through the gas engine frame to the point *B* as shown by the dotted line in Fig. 2. Hence the spark was very feeble. When the wires were disconnected from the dynamo brushes, the engine was started without difficulty. After putting fresh insulation on the dynamo brush holders, a change was made in the wiring by substituting a double-pole switch for the one having a single pole, so that the wiring diagram now corresponds to Fig. 3. If the dynamo should get in a bad condition, it would have no effect on the battery current when starting the engine, since both lines are broken by the double-pole switch. The discovery that the spark behaved differently when the sparking plug was in its place in the cylinder than when it was held in the hands, was purely accidental, and the designer of the engine came in for a good share of the blame for not arranging things so that the spark could be inspected under normal conditions. The dynamo is now wiped off clean every morning, and no further trouble has been experienced. L. K. W.

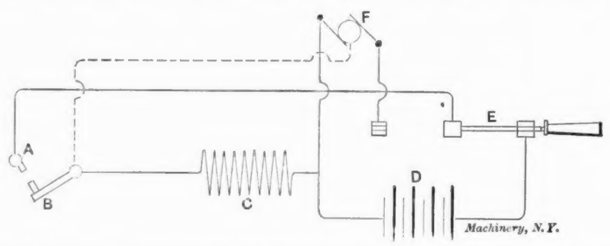


Fig. 2. Diagram showing by the Dotted Line how the Current followed the Path of Least Resistance when the Dynamo Brush was grounded.

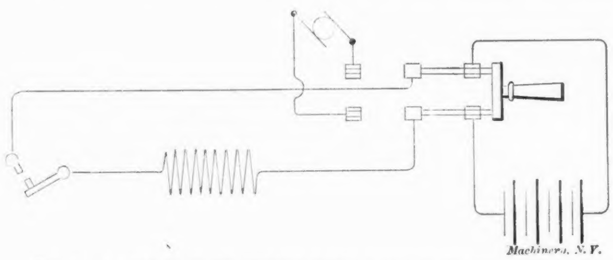


Fig. 3. A Change in the Wiring which prevents the Short Circuit illustrated in Fig 2.

THE GROWING INEFFICIENCY OF WORKMEN.

In the December issue of MACHINERY I noticed an editorial, "The Growing Inefficiency of Workmen," and I can say that it is only too true; but what is the cause of this sad condition to-day?

When the writer and hundreds of others of the old-time mechanics learned their trades twenty-five or thirty years ago, we took pride in doing our work, even if it was only babbitting a journal box. The proprietors of our shops encouraged us in doing work right. What are the circumstances to-day? To-day it is quantity. It is how much work can you turn out? Are you a specialty man? To-day the manufacturers divide their work; they have lathe hands, planer men, milling machine men, bench hands, and floor

men. If you apply for a job as an all-around man they look upon you as a curiosity. In the days when we learned our trades there were no specialty men; they were either all-around mechanics or handy men. A mechanic in those days could fit locomotive links, run a bolt cutter, cut and thread a piece of pipe, or do whatever else the job demanded to make it complete. What is the average so-called mechanic to-day? Is he ever sent out to take charge of a big erecting job or to fit up a complicated piece of work? Not that anyone knows of!

In our day we served three, and sometimes four, years. Our foreman encouraged us not only to think but to put our ideas into execution. He used to say: "Study, boys; learn why you do a piece of work this way or that way. Never take anything for granted on some person's say-so; if you do you only become a machine, you will never become any better than one, and you will always be treated like one." Our old foreman's reasoning holds true to-day. I sometimes think that the average man who passes as a mechanic to-day is more of a machine than a human being. He seemingly has gotten into an automatic way of doing things, and has no conception that circumstances alter cases, or that what might prove effective in one case might be almost disastrous in another. Who is to blame? In the first place, there is a demand for something cheap by a class of people who buy cheap if they buy at all. Then there is a class that manufactures for the cheap trade, and a class of merchants that buys cheap goods and palms them off on unsuspecting people for first-class articles.

In the second place, the unions take in the specialty men, and give them union cards. They go out and represent themselves to be mechanics, whether they know anything or not. They come into competition with men who have learned their trades and who *are* mechanics. The average manufacturer uses the cheap specialty man to hold the real mechanic cheap. What inducement will there be for a man to become a first-class mechanic until manufacturers hire first-class mechanics only, and establish apprenticeship systems that will turn out first-class mechanics?

Let honest manufacturers and mechanics cooperate to put the cheap manufacturer, the dishonest dealer and the cheap mechanic out of business, or, at least, to put them into a recognized position where the general public will know who and what they are. Let honesty be the watchword of both the manufacturer and the mechanic, and let them be satisfied with fair profits and fair wages. Let us leave behind us the present era of bloated dividends, won from the making of dishonest goods—goods in which cheap materials, poor workmanship, plenty of paint and the buffing-wheel create a mockery for the unwary buyer.

When the days of the honest manufacturer and honest workman come—if they ever do—we will have mechanics who are all that the name implies, but not until then. Now, do not think that I believe all manufacturers and workmen of the present time are dishonest; far from it, but anyone who has kept in touch with the manufacturing conditions knows that in the mad rush for wealth they, both high and low, have trampled the good principles of our forefathers under foot to worship at the shrine of Mammon. E. G.

MILLING FIXTURE FOR FINISHING GEAR SEGMENTS.

Some years ago the writer met with a job requiring the finishing of 500 gear segments, of the type shown in Fig. 1. As seen from the cut, these segments were provided with an arm longer than the radius of the gear segment itself, which prevented them from being turned in a lathe, excepting by working the lathe back and forth by hand. As this method was very inconvenient, the following device was designed and put into operation:

A plain milling machine was selected for doing the work, as it would be comparatively easy to mill the face and the sides of the gear segments if a suitable fixture for revolving the work were provided. The pinion for feeding the table of the milling machine was disconnected from the shaft. Then a bracket *B*, as shown in Fig. 2, was made and bolted to the table. This bracket was provided with a projecting lug, which contained a set-screw *F*, for facilitating the setting of the device to the proper position on the table, before being bolted down. The bracket *B* carried an arbor *C* for holding the blank while it was being milled. The arbor *C*, with the blank, was driven from the pinion *D*, which was placed on the end of the feed shaft of the table, which, in this particular machine, came through the frame of the machine, so that one could tap a stud for the gear into it. It was, however, not possible to use a gear on stud *C* as large as would be required to mesh with the gear *D*, on account of interference with the supporting arm of the milling machine, and therefore the idler *E* was placed between the gear *D* and the gear on arbor *C*.

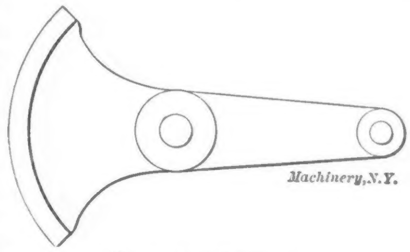


Fig. 1. Gear Segment.

For finishing the blank, three milling cutters were used, one face and two side or straddle milling cutters, and the work of milling the face and the sides of the gear segments was completed in one cut. The device worked very well, and the blanks were finished at a fraction of the time which had been required by other methods previously employed.

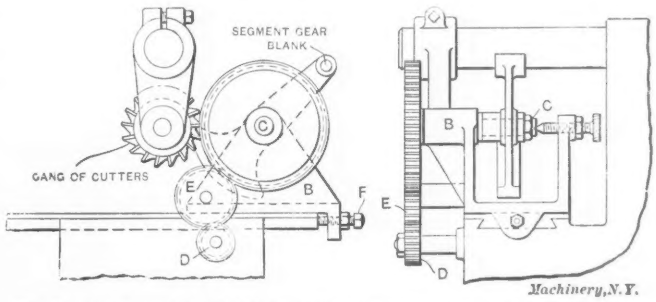
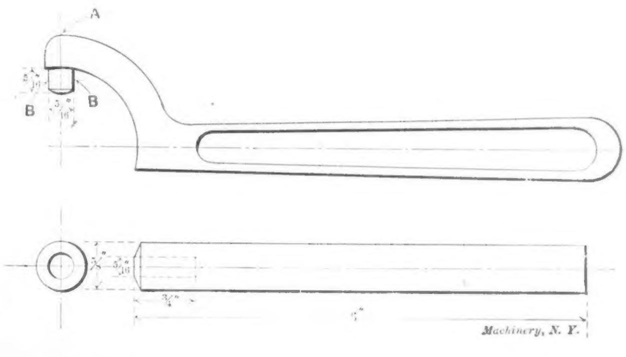


Fig. 2. Attachment for Finishing the Gear Segments on the Milling Machine.

W. ALTON.

REMOVING FINS FROM THE PINS OF SPANNER WRENCHES.

A manufacturing firm had received a large number of drop-forged spanner wrenches of the type shown in Fig. 1, the pin of which was to fit in a 5/16-inch hole in a packing-nut. The wrenches, it was found on inspection, would not fit the hole, because the pins had a fin projecting about 1/16 inch on each side at *B*. The only remedy for this fault seemed to be to file and fit each of the wrenches to a 5/16-inch gage.



Figs. 1 and 2. Spanner Wrench and Tool for Removing Fins.

The job was given to me to do, so I proceeded to file and fit a number, but after awhile I found that this process was going to take too long, and cost too much, so after some thought I decided upon the following plan, which did the job in about one-tenth of the time it would have taken by the previous method: I took a piece of ⅝-inch tool steel, 6 inches long, and drilled a 5/16-inch hole in the center of one end, about ¾ inch deep; then I filed the stock to a bevel around the hole, as shown in Fig. 2. The drilled end of the

piece was then hardened in the same manner as an ordinary punch or die. The piece was then fastened perpendicular to the bench in a strong, heavy vise, and was ready for service.

The process of removing the fins was performed by holding the wrench so that its pin came directly over the 5/16-inch hole in the tool steel rod. Then one or two blows with a heavy hammer at the point *A*, Fig. 1, removed the fins quickly, so that all the wrenches fitted well, and the work was finished nice and smooth. A little oil on the tip of the wrench kept the stock from tearing. ROY B. DEMMING.

Geneva, N. Y.

A GOOD BOX TRUCK.

For convenience in handling our small brass fittings, both before and after machining, they are put into small wooden boxes and carried wherever wanted by means of a small truck, which is light, and easily handled, and which takes up little space when not in use.

The boxes are made of a good grade of one-inch lumber, and are 16 inches long, 10 inches wide and 9 inches deep, outside measurement. They are bound with heavy strap iron, making them very serviceable and long-lived. One of these boxes is shown in Fig. 1. The figures on the end denote

Figs. 1, 2 and 3. Box Truck for Shop Use.

weight of box. All boxes are marked this way for convenience in weighing, and their weight will vary from six to nine pounds.

The truck shown in Figs. 1, 2, and 3 is made in the factory for our own use only. The frame is made of seasoned oak, bolted together with ¼-inch bolts. The center piece or handle is 4 feet long, 2 inches wide, and 1¼ inch thick. The side pieces are 3 feet long, 1½ inch wide, and 1 inch thick. The frame is 12 inches wide, at top and 11 inches at bottom. The bottom of the frame is 2½ inches square, and through this is run a ½-inch bolt which serves as an axle for the wheels. The wheels are ordinary cast iron wheels, 1¼ inch wide by 4 inches diameter.

The iron work shown on the trucks is all hand-forged. The hook shown fastened to the center piece is also hand-forged, and is so made that it will lie back against the frame as shown in Fig. 2, and when the truck nose is shoved under a box, a quick jerk causes the hook to drop into position shown in Fig. 1.

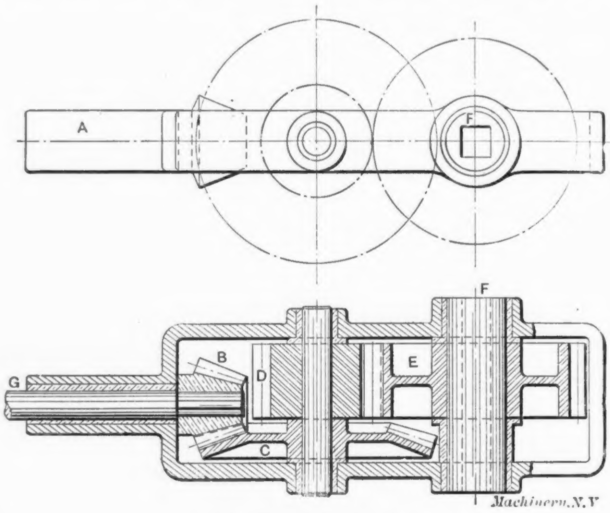
Holes are drilled through the center brace at various heights so that the hook may be placed in proper position for different sized boxes. A small cotter pin is used to keep the hook in whatever hole it is placed.

Reference to Fig. 1 will show that when the hook is in position to hold a box, there is a projection pointing to the rear so placed that the hook can be lifted out of the box with the foot. With very little practice, boys learn to handle boxes full of brass fittings quickly and easily without touching a hand to them. ETHAN VIALL.

Decatur, Ill.

RIGHT-ANGLE POWER HEAD FOR DRILLING AND REAMING HOLES.

The accompanying cut illustrates a right-angle power head which is used principally for drilling and reaming holes in locations where it is impossible to use the regular tools. Especially is the tool found very valuable where traction engines, locomotives, or cars are being repaired. It is often found that the pneumatic drill, or the electric drill, are too



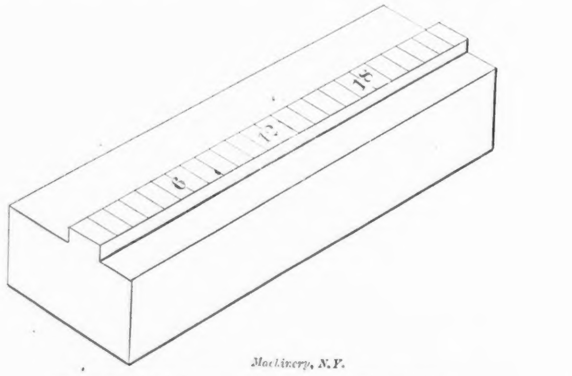
Right-angle Power Head.

large to be used, because of the lack of room, and the only tool that can be used is a ratchet. This power head requires less room than the ratchet. The drill or reamer fits into one end of the square socket *F*, and a small feed screw in the other. This socket is formed in a steel sleeve, which is keyed to the spur gear *E*, having 26 teeth, 5 pitch, and 1¾-inch face. The spur gear *E* is driven by the steel pinion *D*, having 14 teeth. On the same shaft with the pinion *D*, the steel bevel gear *C* is fastened. This gear has 36 teeth, 6 pitch, and 1¼-inch face. The main driving pinion *B* is made of hard brass, and it has 12 teeth. This pinion is keyed to the stub shaft *G*, which is attached to a flexible driving shaft. The shaft *G* can, of course, be driven in other ways if more convenient. The head frame *A* is made of cast iron, and each bearing is bushed with bronze. I believe that most shops will find this power head to be a valuable tool.

Denver, Col. T. B. BURNITE.

GRADUATING ON THE PLANER.

While the planer might not be considered the tool best adapted for graduating, I will describe a case in which I found it both accurate and quick. I had a number of drawn steel bars, from 4 to 12 inches long, to be graduated in sixths of an inch, as shown in the sketch. No miller was available, and the job was marked "rush." The 18-inch planer had a



Steel Bar which was graduated on the Planer.

double threaded cross feed screw with a 1/3-inch lead, and was driven through a 32-tooth ratchet wheel, so I set the feed to move 16 teeth at a time, which gave me a movement of 1/6 inch for every stroke. Putting the vise on the planer, and grinding a V-point tool, completed the preliminary arrangements. The bars were then put in the vise. The tool

was set to the proper depth and brought to the end of the work, after which it was only necessary to throw in the feed pawl and start the machine. The scales were cut at the rate of 5 inches per minute, which is very good time for an odd job. It was, of course, necessary to lift the tool on the return stroke.

DONALD A. HAMPSON.

Middletown, N. Y.

INDICATING FINISHED SURFACES—RECORDING CHANGES ON DRAWINGS.

The article by C. T. in the July, 1907, issue of MACHINERY, entitled Indicating Finished Surfaces, reminds me of a somewhat similar system of finishing marks which, to my mind, is simpler and fully as effective as the system mentioned by C. T., and which has also been in use for several years. In this system the various classes of finish are designated by number, as follows:

Finish No. 1 requires surfaces to be extremely smooth and accurate within a tolerance of ± 0.0005 inch.

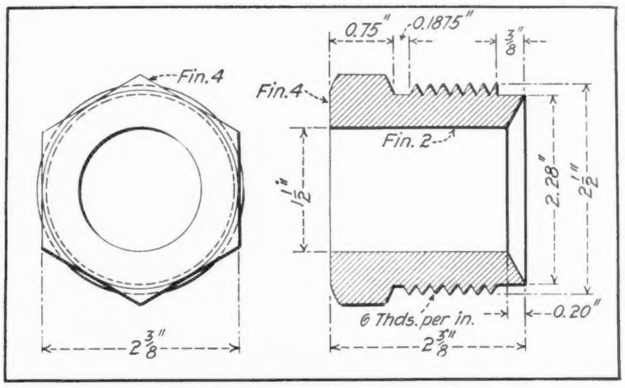


Fig. 1. System of Indicating Finished Surfaces, applied to a Drawing.

Finish No. 2 requires surfaces to be very smooth and accurate within a tolerance of ± 0.001 inch.

Finish No. 3 requires surfaces to be smooth and accurate within a tolerance of ± 0.003 inch.

Finish No. 4 requires surfaces to be accurate within a tolerance of ± 0.005 inch.

Finish No. 5 requires surfaces to be rough machined or filed to within a tolerance of ± 0.025 inch.

Finish No. 6 requires that castings or forgings be cleaned of all sand, scale, risers, fins, etc.; and that no thickness of

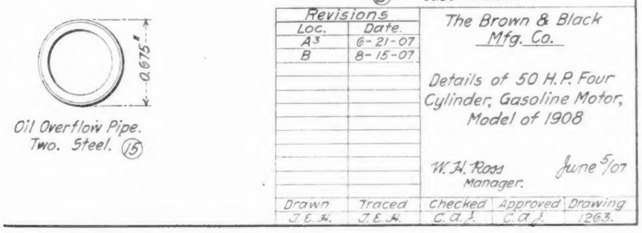


Fig. 2. Method of Recording Changes on a Drawing.

metal when ready to assemble shall differ from drawing dimensions more than ± 5 per cent.

All allowance for fit is to be made on the female parts. Male parts are to be made to the standard size.

With the above system, used on drawings as indicated in Fig. 1, work can be laid out to any degree of accuracy required and the workman readily knows between what limits of accuracy he must make any dimension. In cases where the piece can be made satisfactorily with one grade of finish all over, a note may be added to the name, etc., of the piece on the drawing to that effect. For example, the specification: Washer—Finish No. 4, attached to the drawing of a washer would indicate that no dimension need be worked closer than ± 0.005 inch to the specified sizes.

The recording of changes or revisions made on drawings of any kind is of the greatest importance, and Fig. 2 illustrates

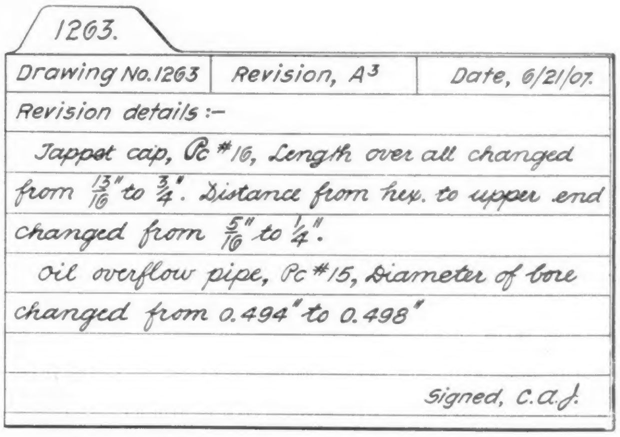


Fig. 3. Card System with Complete Record of all Revisions.

a very satisfactory method of recording changes on a drawing. The columns headed Revisions show the location on the drawing of dimensions revised and also the date when the revisions were made. The small figure at the right of the letter of revision in the column indicates how many places on the drawing the revision affects. For instance, the revision A^3 affects the drawing in three places, while B affects it in only one place, as shown. It is a matter of opinion as to how to remove the old dimension and place the new dimension in its place, but, personally, I very much prefer that the old dimension be merely crossed out and the new dimension be shown above it, as in Fig. 2.

It is advisable, on account of its simplicity and the possibility for ready reference, that a separate file of revision records for each type of machine being manufactured be kept. A card system, of some such form as shown in Fig. 3, is preferred by the writer, because its flexibility allows for sufficient expansion to cover all details concerning any revision that may be made in any drawing. The cards in the revision file are indexed by the drawing numbers, and are arranged in their several indexed spaces in the alphabetical order in which the revisions were made. By the above method a complete record of all changes, on any piece, shown on any drawing and belonging to any machine, can be kept in compact form and in condition for immediate reference at any time.

W. E. C.

FORMULAS FOR MILLING END MILLS AND CLUTCHES.

In the following the writer has shown the method by which a formula is arrived at for the correct setting of the index head of a milling machine for milling the teeth on the ends of end mills, on the sides of side or straddle milling cutters, etc. A formula is also deduced for the setting of the index head when milling the teeth of clutches.

Referring first to the question of end mills, let it be assumed that the number of teeth, and the angle of the angular cutter with which the teeth are to be milled are given. The angle sought is the one to which to set the index head of the milling machine. In Fig. 1 the problem is shown diagrammatically, the cutter angle ADB, and the number of teeth, n, being given, while the angle to which the index head is to be set (which is to be determined) is BEC. In order to simplify the calculations, assume the radius of the end mill to equal 1. Evidently, the length of the radius has no influence on the final result, or on our formula, anyway. The angle BCM represents the angle of one tooth of the end mill. Now, produce CM to A and draw AB. The line CE represents the bottom of the tooth, and the plane in which the angle of

the cutter for milling the teeth must be measured, is at right angles to *CE*, or in the plane *BD* (lower view of Fig. 1).

We can now arrive at the following equation:

$$\text{Angle } ACB = \frac{360 \text{ deg.}}{n}$$

$$\tan \frac{360 \text{ deg.}}{n} = \tan ACB = \frac{AB}{BC}$$

But BC = radius of end mill = 1, and consequently

$$\tan \frac{360 \text{ deg.}}{n} = AB \qquad (1)$$

The triangle *ABD*, shown at the right in Fig. 1, is in a

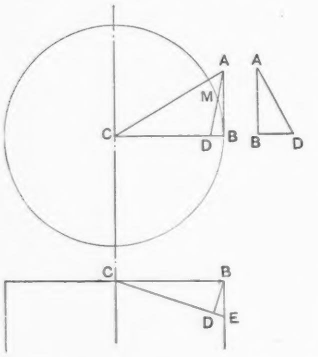
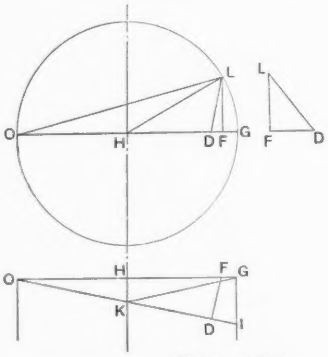


Fig. 1. Deriving Formula for setting Head for cutting End Mills.



Machinery,N.Y.

Fig. 2. Deriving Formula for setting Head for cutting Clutches.

plane perpendicular to the bottom *CE* of the tooth, the angle *ADB* being the cutter angle, as mentioned. Then

$$BD = AB \times \cot ADB = \tan \frac{360 \text{ deg.}}{n} \times \cot ADB \qquad (2)$$

The line *BD*, however, also lies in the plane containing the right triangle *CDB*. We have, therefore,

$$\cos CBD = \frac{BD}{BC} \qquad (3)$$

But BC = radius of end mill = 1, and consequently, from (2) and (3):

$$\cos CBD = BD = \tan \frac{360 \text{ deg.}}{n} \times \cot ADB \qquad (4)$$

The angle *CBD* equals the angle *BEC*, or the angle to which to set the index head; therefore,

$$\cos BEC = \tan \frac{360 \text{ deg.}}{n} \times \cot ADB, \text{ or, expressed in words:}$$

The cosine of the angle to which to set the index head equals the tangent of the tooth angle multiplied by the cotangent of the angle of the cutter by which the teeth are cut.

[This formula, expressed in words, was contributed by Mr. George Porter to MACHINERY, April, 1904, but the derivation was not given in Mr. Porter's article. For table see MACHINERY Data Sheet, May, 1904.—EDITOR.]

Clutches, in order to fit into one another, must have the bottom and top of the teeth inclined at corresponding angles, as shown by lines *KG* and *KI* in Fig. 2. Assume that the number of teeth *n* and the cutter angle *LDF* are given, and that the radius $HG = 1$. The angle $LHG = 360$ degrees divided by the number of teeth. Draw *LF* through *L* perpendicular to *OG*. The line *KI* represents the bottom of the tooth. Produce *KI* to *O*. The plane in which the angle of the cutter for milling the teeth must be measured, is perpendicular to *OI*. Assume, therefore, that the angle is measured in a plane *FD* (see lower view of Fig. 2). Angle $LHG = \dfrac{360 \text{ deg.}}{n}$.

$$LF = \sin LHG \times HL = \sin \frac{360 \text{ deg.}}{n}$$

The triangle *LFD*, shown at the right in Fig. 2, is in a plane perpendicular to the bottom *KI* of the tooth, or perpendicular to *OI*, the angle *LDF* being the cutter angle, as mentioned. Then $FD = LF \times \cot LDF = \sin \dfrac{360 \text{ deg.}}{n} \times \cot LDF$.

But *FD* also lies in the plane containing the right triangle *ODF*. Therefore,

$$HF = \cos LHF \times HL = \cos \frac{360 \text{ deg.}}{n}$$

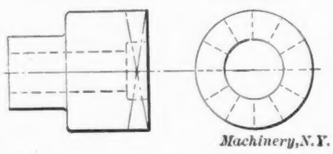
$$OH = 1.$$

$$OF = OH + \cos \frac{360 \text{ deg.}}{n} = 1 + \cos \frac{360 \text{ deg.}}{n}$$

$$\cos OFD = \frac{FD}{1 + \cos \dfrac{360 \text{ deg.}}{n}} = \frac{\sin \dfrac{360 \text{ deg.}}{n} \times \cot \text{ cutter angle}}{1 + \cos \dfrac{360 \text{ deg.}}{n}}$$

The angle *OFD* equals the angle *OIG*, or the angle to set the index head. Therefore the previous formula expressed

TABLE OF ANGLES TO WHICH TO SET HEAD-STOCK OF MILLING MACHINE WHEN CUTTING CLUTCHES WITH ANGULAR CUTTERS.



Machinery,N.Y.

The cosine of the angle to which the milling machine index head is set, equals the sine of the tooth angle multiplied by the cotangent of the cutter angle, divided by the cosine of the tooth angle plus 1.

No. of Teeth.	Angle of Cutter.			No. of Teeth.	Angle of Cutter.		
	60°	70°	80°		60°	70°	80°
5	....	....	82° 12′	18	84° 9′	86° 19′	88° 13′
6	....	77° 52′	84° 9′	19	84° 30′	86° 31′	88° 19′
7	73° 50′	79° 54′	85° 10′	20	84° 46′	86° 42′	88° 24′
8	76° 10′	81° 20′	85° 48′	21	85° 1′	86° 51′	88° 29′
9	77° 52′	82° 23′	86° 19′	22	85° 13′	87°	88° 33′
10	79° 12′	83° 13′	86° 43′	23	85° 27′	87° 8′	88° 37′
11	80° 14′	83° 54′	87° 4′	24	85° 38′	87° 15′	88° 40′
12	81° 6′	84° 24′	87° 18′	25	85° 49′	87° 22′	88° 43′
13	81° 49′	84° 51′	87° 30′	26	85° 59′	87° 28′	88° 46′
14	82° 26′	85° 12′	87° 42′	27	86° 8′	87° 34′	88° 50′
15	82° 57′	85° 34′	87° 51′	28	86° 16′	87° 39′	88° 52′
16	83° 24′	85° 51′	87° 59′	29	86° 24′	87° 44′	88° 54′
17	83° 48′	86° 6′	88° 7′	30	86° 31′	87° 48′	88° 56′

in words, reads: *The cosine of the angle to which to set the index head, when cutting clutches, equals the sine of the tooth angle multiplied by the cotangent of the cutter angle, all divided by the cosine of the tooth angle plus 1.*

The accompanying table gives the angles for setting the index head when cutting clutches, figured from the formula given.

IRVING BANWELL.

Belvidere, Ill.

TO CALCULATE THE SIDE OF AN INSCRIBED POLYGON.

Sometimes we do not have our tables handy, and in such a case it is advantageous to know how to construct one, or to calculate a quantity for ourselves. Take, for instance, the length of the side of an inscribed polygon of any number of sides, which increases in geometrical proportion by two, as in the series 4, 8, 16, 32, 64, etc. To solve this problem we can start with the fact that when the radius is unity, the side of the inscribed square will be $\sqrt{2} = 1.4142$. Then the values of the other terms of the series will be as follows:

$$4 = \sqrt{2} = 1.4142$$

$$8 = \sqrt{2 - \sqrt{2}} = \sqrt{2 - 1.4142} = \sqrt{0.5858} = 0.7654$$

$$16 = \sqrt{2 - \sqrt{2 + \sqrt{2}}} = \sqrt{2 - \sqrt{2 + 1.4142}} = \sqrt{2 - \sqrt{3.4142}} = \sqrt{2 - 1.8477} = \sqrt{0.1523} = 0.3902$$

and so on, the signs always commencing with minus and then alternating with minus and plus.

ROBERT GRIMSHAW.

Hanover, Germany.

IMITATIONS OF AMERICAN MACHINE TOOLS.

The complete and painstaking imitations of American machinery, which a number of German firms are now engaged in manufacturing, is a matter which must sooner or later be considered as a factor having more or less effect on the extent of American foreign trade. It has fallen to the lot of the writer to be in a position where this practice is under his constant and direct observation, and he believes the time has come when a word must be uttered for the benefit, or at least, information, of the people who have spent time, study and money in perfecting and patenting their ideas. Not only is the manufacturer concerned in this subject, but the firms that handle American machinery abroad stand to lose considerable, should there be found no method of checking this piracy.

Almost invariably, before a new machine can be successfully sold in Europe, there must be considerable sums of money spent in advertising and demonstrating, and, as only a short time elapses before one or more of these "Nachahmen" firms has the matter under consideration, it generally happens that about the time the American machine is meeting the approval it deserves, there is quietly insinuated on the market, a "made in Germany" article, which, as far as appearance is concerned, might have been the issue of the same parentage. However, some small amount of comfort can be derived from a consideration of the results.

In one case in which I was personally interested, an American automatic was purchased by a Berlin firm, and a German imitation was installed beside it on the same work. The German machine had the advantage of national prejudice, but I was proud to find that the weekly output was 15 per cent in favor of the American article. The fault in this case was with the spindle, which was not properly scraped in, and in consequence heated frequently.

A friend of mine was once traveling through China. He had a pair of duck trousers which had seen service in the Philippines, and he decided to order a more presentable pair to wear when returning home. So he took them to a Chinese tailor and gave him orders to make another pair exactly like the sample. He received them in due time, and the practical example of the Chinaman's ability to make a perfect copy of a given article, as demonstrated by the work done on those duck trousers, left an impression which nothing could remove. John Lee had faithfully reproduced every detail, the most striking of which was a fair-sized hole, which in the case of both the original and the copy could only be hidden when the wearer assumed a position of rest.

So also is the case here, but I believe the idea in so faithfully copying every detail and not adding any improvements is because of the danger they incur of making something which will not run.

An acquaintance of mine here, a Pennsylvania Dutchman, owner of a small shop, was once in need of a grinding machine. He was visited by one of these "plagiarists" and received an offer of a "made in Germany" grinder at a few dollars reduction in price. A superficial inspection of the machine convinced my friend that it was made in the image of a well-known American design, but a point he almost immediately noticed was that while one center was ground to a 60 degree angle the other was finished at a much blunter angle.

This startled my friend and he pointed out the difference. The maker answered, "Yes, but that is nothing to complain about. Why should a little difference in angle be of any account? The machine is the same as your American grinder." "Yes," answered my friend, "but if you have exercised the same judgment in copying the machine as you have in the centers (which is of the most vital importance), I guess I'll look somewhere else for a grinder. I wouldn't take your machine as a gift."

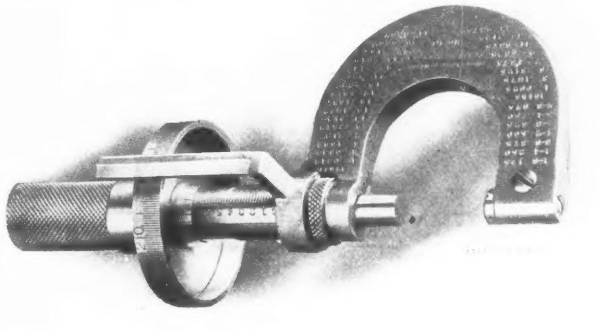
A striking case of so-called improvements was in evidence at the Automobile Show recently held in Berlin. A firm whose business is almost exclusively the copying of the well-known Cleveland automatic, had a machine on exhibition made after the design of the new 3-hole automatic recently brought out in Cleveland. Now, as is well known, the feature of the regular Cleveland automatic is the differential feed through adjustable cams and friction disks.

The 3-hole machine is a special machine designed with a view to cheapness, positive feed and speed, and adaptability for a great range of work. This German concern copied the construction of the machine made necessary because of the changed feed, and then in addition put in the friction feed, etc. The result is a hybrid that is neither ornamental nor useful. The feed is neither regular nor positive, as was demonstrated by the trouble they had in attempting to use a geometric die head. On account of the trouble they had in keeping the feed regular, the die would sometimes open too soon and at other times not at all. However, the natural desire to save a few dollars which actuates most buyers of machinery, often prevents the sale of the original article, and for this reason the writer believes something should be done by American manufacturers, if possible, to correct the evil. DAVID R. MILLINGTON.

Berlin, Germany.

MICROMETER ATTACHMENT FOR READING TEN-THOUSANDTHS.

The accompanying half-tone illustration shows an attachment for micrometers which I designed and made for reading in tenths of thousandths. With very little fitting it is interchangeable for 1, 2 or 3-inch B. & S. micrometers. The idea is simple, as can be seen by the illustration. The diameter of the thimble was increased 3 to 1 by a disk which is graduated with 250 lines instead of 25, making each line



Micrometer with Attachment.

represent 0.0001 inch instead of 0.001 inch. A piece of steel was then turned up and bored and cut away so as to form the index blade and a shell to clasp the micrometer frame, the whole thing being made in one piece. The thimble disk being just a good wringing fit, it can be easily adjusted 0 to 0. The attachment can be removed when fine measuring is not required. P. L. L. YORGENSEN.

Hartford, Conn.

METHOD OF TRUING UP OILSTONES.

There seem to be a great many mechanics who do not know how to true up their oilstones. Every now and then you will see a man spoil a good stone by trying to grind it true on the emery wheel, which usually cracks the stone into several pieces, or checks it with fine cracks which sometimes are almost invisible to the naked eye. My method of truing up an oilstone may not be new to all, but I know from experience that there are many who do not know about it. Take a piece of planed cast iron, and cover the machined surface with loose emery mixed with water. Then place the oilstone upon this surface and grind it true. This can be quickly done if water is used with the emery, as water is much better than oil for this purpose. I have trued up many kinds of stones in this manner, from a coarse India oilstone, to a fine Swaty razor-hone. Stones with special shapes may be formed by planing a groove of the desired shape into a cast iron block, and then drawing the stone back and forth through this groove, using emery and water as before. Those who try this method of truing up an oilstone will find the results satisfactory, and stones which are much worn and useless, can be made almost as good as new. J. J. VOELCKER.

Decatur, Ill.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

DESCRIBING A CIRCLE AROUND A DRILLED HOLE.

Occasionally it is required to describe a circle about a small drilled hole, the method in vogue being to do this with dividers and a ball center. In the absence of the latter, the dividers can be used by putting a sharp prick punch mark in a buckshot, inserting one leg of the dividers firmly in this mark, and proceeding as usual. DONALD A. HAMPSON.

Middletown, N. Y.

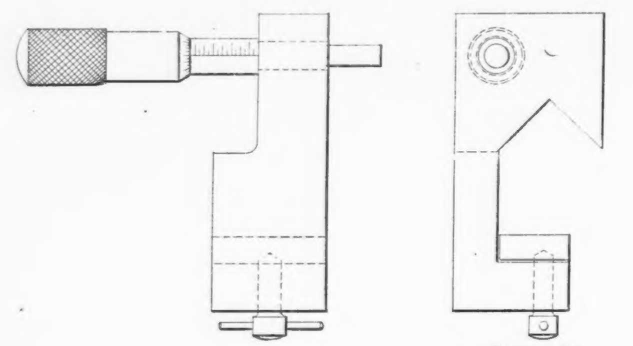
A TIME-SAVING DRAFTING KINK.

A great saving in time, which even well systematized drafting rooms seem to overlook, can be effected by putting one or two tracers to work cutting up a quantity of standard sizes of tracing cloth, drawing the border lines around them, stamping them with the standard marking, simply leaving out the name of the piece, date, and draftsman's initials, which, of course, are filled in when the tracing is made. This saves every man going and cutting up a piece of tracing cloth each time he is to make a tracing. It makes it very convenient for the tracers as they can get the size sheet they want, tack it down, and trace in the drawing right away, without bothering with cutting to size, measuring the outline, and putting on the borders and title stamp. This plan also saves a lot of waste of tracing cloth. F. L. ENGEL.

New Britain, Conn.

MICROMETER STOP FOR THE LATHE.

The micrometer stop shown herewith is used on the engine lathe for obtaining accurate movements of the lathe carrriage. It consists of a micrometer head, which can be purchased from any micrometer manufacturer, and a machine steel

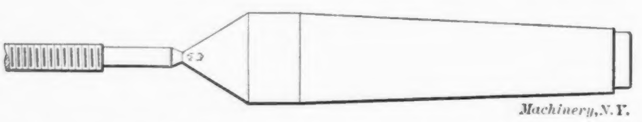


body which is bored to fit the micrometer head. This tool is clamped on the front way of the lathe bed, and when the jaw of the micrometer is against the lathe carrriage, it can easily be adjusted to the thousandth of an inch. Of course, care should be taken not to bump the carriage against the micrometer. J. L. MARSHALL.

Dayton, O.

TURNING AND THREADING NEEDLE POINTS FOR CARBURETERS.

The accompanying cut shows a little kink which saved time and trouble in the shop where I am employed. We were turning and threading needle points for large engine carbureters. These were made from brass rods 5/16 inch in diame-

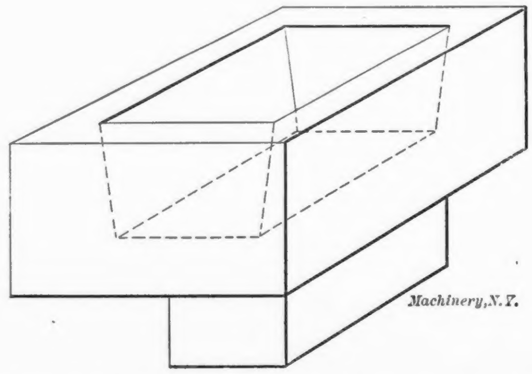


ter, by 4¾ inches long. The rod was first held in a small chuck and beveled on one end. It was then pulled out a little over 4¾ inches, and we were then ready for turning and threading the piece. In order to be able to get a support for the pointed end, we drilled a center hole in the tail-stock center of the lathe, and placed the rod with its 60-degree beveled end in the tail center, as shown in the cut. By this means it was possible for us to turn and thread the needle points without much trouble. J. D. COE.

Lansing, Mich.

BABBITT RIVETING BLOCK.

Some time ago one of the boys told me he was tired hunting up new pieces of babbitt or lead to rivet on, so I fixed up a "wrinkle" that helped him out finely. I asked the patternmaker to make a pattern for a little box, as shown in the accompanying cut, and from it got a half dozen castings. The lug on the bottom makes it convenient to hold in the vise. The

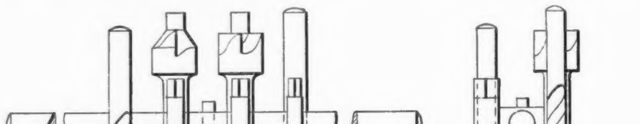


hollow top is poured full of babbitt (or lead), thus forming a soft anvil that lasts much longer than a plain piece of babbitt, as it is supported on all sides by hard metal which prevents the mushroom effect. When the babbitt gets so battered up that it cannot be used longer, we hold the block in the flame a few moments until it melts, and then pour the babbitt over again. The scheme saves time and babbitt, *i. e.*, money. C. H. RAMSEY.

Paterson, N. J.

BLOCK FOR HOLDING TAPS AND TAP DRILLS.

The accompanying cut shows a block which has proved very handy in our shop. It is intended for holding the three taps in the set, one tap drill, one full size diameter drill, one counterbore, one counter-sink, and a tap wrench. By having the tool-room provided with blocks such as these, when a man wants taps and drills or counterbores for a certain job, he simply asks for block number so and so, and he receives then



the block with all the accompanying tools. There is a great deal of time saved as compared with such systems where the man first has to ask for the taps, and then for the tap drill, and finally for the counterbore and counter-sink. Such methods in a shop tool-room ought to be considered obsolete. Tools belonging together should be kept together, and the best way for doing this is undoubtedly by using some kind of a block similar to that shown in the cut. F. RATTEK.

Brighton, Mass.

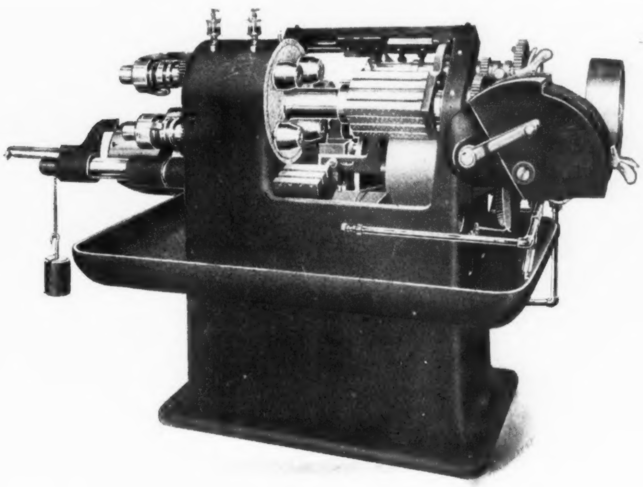
NEW MACHINERY AND TOOLS.

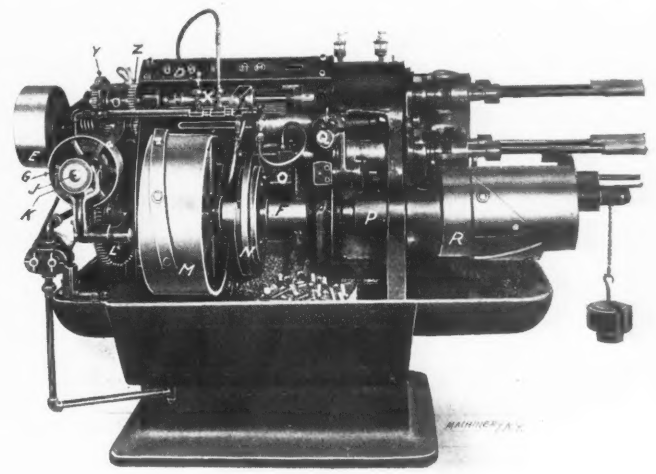
A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

THE GRIDLEY MULTIPLE SPINDLE AUTOMATIC SCREW MACHINE.

The following paragraphs and the accompanying engravings describe and illustrate a new multiple spindle automatic screw machine, the invention of Mr. G. O. Gridley; it is built by the Windsor Machine Co., of Windsor, Vt., maker of the Gridley automatic turret lathe.

In the principle of its action (see Fig. 4), this tool follows the same plan as other commercially successful machines of its type. It is provided with an indexing head, carrying a number of revolving spindles. Each of these has a chuck and feeding collet for holding and handling the stock, of which there are as many bars as there are spindles—in this case, four. A tool-slide is provided, with a place for a tool opposite each work spindle, with means for feeding the tools simultaneously toward the head. Cross-feeding tool-holders for forming and cutting off are also provided, operating on the bar whose spindle is in position opposite it at the time. The spindle head is indexed periodically to bring each bar of stock in turn opposite each of the tools in the tool-holder, and in position to be formed and cut off as well, these operations all taking place simultaneously on different bars of stock. Thus a completed piece of work—turned, threaded, formed and cut off—is produced for each indexing of the spindle head.





Figs. 1 and 2. Front and Rear Views of the Gridley Multiple Spindle Automatic Screw Machine.

The time required to complete a piece of work is the time required for the longest operation, plus the time consumed in the so-called "idle" movements. Sometimes, as in the turning operation in Fig. 4, a long operation may be split in two, thus materially increasing the output per day. All the other operations, except the longest, are, of course, working at less than the maximum feed of which they are capable, so that conditions are favorable to good work.

Mechanism by which the Machine is Operated.

The mechanism used to accomplish these various movements will be best understood by referring to the rear view of the machine, Fig. 2, in connection with Fig. 1.

The revolving head has a stem or shank solid with it, on which is mounted the "turret" or tool slide. This latter is guided in alignment with the work spindles by a fork having a carefully fitted bearing on the tie-piece *D*.

Driving pulley *E* is keyed to a shaft which passes through the hollow shank to the rear of the head, where it carries a gear meshing with the driving gears of the spindles, which are thus rotated continuously in the same direction, without provision for stopping or reversing. (See also Fig. 5.)

The various movements of the machine are all controlled by a cam-shaft *F*, at the rear of the machine. This cam-shaft may be driven at either of two speeds. One of them, that for feeding the tools, is obtained from spindle-driving pulley *E*, through a double worm reduction and the quick change gear mechanism in the gear box. For the rapid movements, constant speed pulley *G* is connected by a friction clutch with the worm-shaft *J*, by which the cam-shaft *F* is revolved. When this is done, the worm-shaft runs ahead of the slow movement given it by its connection with the spindle, a ratchet mechanism being provided for this purpose. The throwing in of this fast motion is effected by clutch lever *K*, operated by adjustable dogs on disk *L*. By adjusting these dogs, the rapid and feeding movements of the cam-shaft may be made to occupy their proper respective portions of the complete cycle.

The longitudinal feed cam *M* acts on a roll at the rear of the tool-slide. Three cam-plates are furnished, having a 2-, 4- and 6-inch throw, respectively, of which the proper one for the length of the work in any given case is used. This cam, of course, advances all the tools on the slide simultaneously. This movement is positive for both advance and return, no springs being used.

The forming and cutting-off tools are mounted on pivoted holders, which are rocked toward and away from the work by positively acting face-cams on either side of disk *N*. Cutting-off tool-holder *O* also carries the stock-stop, which is presented to the work spindle opposite it just before feeding commences, after the preceding piece has been cut off.

Indexing arm *P* is the next member on cam-shaft *F*. This carries a cam which withdraws the revolving head lock bolt *Q*. It also carries a roll which engages slots in the inner face of the revolving head, the combination working on the plan of the Geneva stop motion, which is the standard mechanism for indexing heavy parts with a maximum of rapidity and a minimum of shock.

Last in order, at the outer end of the shaft, come the cams for operating the rod feed and chucks. These cams are mounted on drum *R*. The stock is fed forward by the usual feed tube and gripping collet, operated by a weight to give the required rapidity of action. The feeding movement for each spindle takes place when it is in the lower rear position.

The threading tool, tap or die, is mounted on spindle *X*, opposite the upper rear position of the work spindle. Spindle *X* is connected with the main driving shaft by either of gears *Y* or *Z*, depending on the position of the clutch between them. In beginning the threading operation, gear *Y* is clutched to spindle *X*, which is thus revolved at a slightly slower speed than the work. The threading tool is then pressed against the work by a cam, and the threading proceeds at a suitable surface speed. When the proper length has been threaded, a trip is released which throws the clutch to engage gear *Z*, which drives the tap or die faster than the work, thus screwing it off.

Cycle of Operations.

The writer saw the machine in operation, making the hex-head cap screw shown at *e* in Fig. 4. The making of this screw will be readily understood, with the preceding description of the mechanism in mind.

We will follow the movements of one of the four bars of stock, starting with it in the front lower position, fed to length, as shown at *a*. When the tool-slide is fed forward, the tool opposite this position (a turner similar to that shown in Fig. 7) takes the cut at the end of the bar as shown at *b*, while the forming tool necks the stock. At the completion of this cut the quick movement of the cam-shaft is thrown in, drawing back the tool, revolving the head, and bringing the tools up again. The bar of stock we are following is now in the front upper position where a second tool completes the turning operation, as shown at *c*. Dividing the turning into two operations increases the output, as previously explained. The head is now again indexed, and this spindle is brought opposite the threading die, which is slowly threaded on to the proper length by the mechanism previously described, and then threaded off again, without requiring the reversal of the spindle. The work, now in the condition shown at *d*, is next brought down to the lower rear position, where it is cut off as shown at *e*. Immediately after it is severed from the bar, the cut-off tool recedes, bringing the stop into line, and the stock is fed forward to it while the other tools are being withdrawn from the bars on which they have been operating.

Fig. 3. Detail View of Spindle Head and Tool-slide.

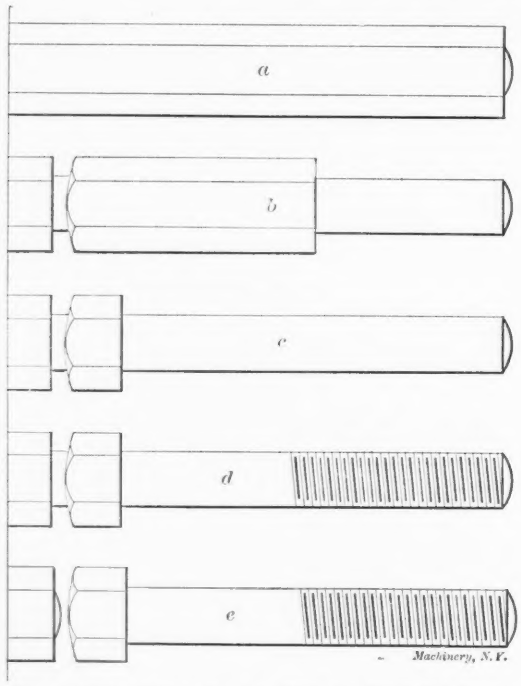


Fig. 4. Cycle of Operations on Hexagon Head Cap Screw.

The Central Theme of the Design.

From the preceding description, it will be seen that the mechanism of this machine is simple, ingenious and effective, and therefore worthy of study. The chief interest in the design, however, centers about a definite constructive principle, which is the foundation on which the tool is built. This idea can be best understood by referring to Fig. 5, which shows the machine partly disassembled.

The prime difficulty in practically applying the multiple spindle scheme, is that of indefinitely preserving the alignment of the spindles with the tools. Fine workmanship may have established correct conditions at the start, but a little wear throws the parts out of line, and it is practically impossible to provide adjustments which will return them again to their proper place.

The reason for the existence of this particular multiple spindle automatic screw machine is seen in the construction of the head, shown disassembled on the floor in Fig. 5. It will be seen that this is a rigid casting, solid with the shank which carries the tool-slide. This shank has a bearing in the frame at the right. This is different from the usual construction, in which the comparatively short length of a large diameter head is depended on to preserve the alignment. It will be easily seen that a considerable wear of the bearing surface would have to take place before the head could "wobble" out of line, guided in parallelism as it is by the long shank.

Besides this, the tool-slide is mounted directly on the shank and moves with it, should the head get out of line. This is not the case with the usual construction, in which the head and the slide are separately supported by the base of the machine, each free to wear out of line or be mis-adjusted, without reference to the other. The value of this arrangement will be at once appreciated.

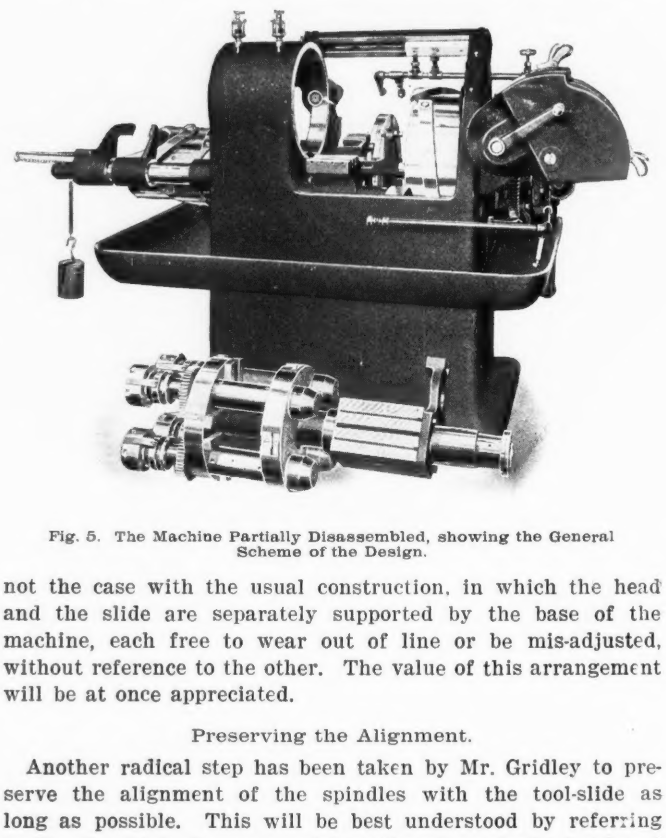


Fig. 5. The Machine Partially Disassembled, showing the General Scheme of the Design.

Preserving the Alignment.

Another radical step has been taken by Mr. Gridley to preserve the alignment of the spindles with the tool-slide as long as possible. This will be best understood by referring to Fig. 6, which shows an axial section through the head and one of the spindles. It will be seen that spindle *T* revolves in a bushing *U* of "Lumen" metal—solid and absolutely unadjustable. This is directly opposed to common practice, which provides elaborate adjustable boxes for the work spindles, with means for taking up the wear as fast as it occurs. The plan in this machine is to give the spindle a bearing of unusual area, in the best metal obtainable, with a fit as nearly perfect to begin with as the expert machinist can produce. With the low pressure per square inch to which such a bearing is subjected, and with the high-grade materials used, the expectation is that long continued use will be required to show anything more than negligible wear. The contention is, that where adjustments are furnished, adjustments will be required, for the parts will be continually getting out of their proper position, by working loose or by being tampered with by ignorant operators. We are believers in the correctness of this idea of carefully fitted, non-adjustable bearing of great area, and recommend it to the consideration of machine designers in cases like this, where the unit pressure can be

brought very low. Incidentally, the construction of the machine is greatly simplified, though this is not the purpose of the design.

If the time ever comes that the spindle wears loose, the old bushing *U* is removed and a new one inserted—a simple and satisfactory way of keeping the machine in good condition. There are two or three other points that may be mentioned in connection with this matter of permanency of alignment. The same plan of non-adjustability, careful fitting and large bearing area has been followed in the case of the bearing of the tool-slide on the shank of the spindle head, and the advantages of the construction apply here with equal force. Note also that the spindles are driven by gears *V* (see Fig. 6) flush with the end of the bearing, so that the lateral thrust is not multiplied by a lever action, as is the case when they are located at a considerable distance from the bearing. Being gear driven, the lateral thrust is, of course, less, anyway, than would be the case with belt-driven spindles.

It will be seen that the form of tool-slide used is an important factor in the matter of preserving the alignment. In the first place, the tools do not overhang at all—see the turning tool in Fig. 7, for instance. Besides this, the surface by which the slide is guided (the bearing of the fork on tie-piece *D*) is of a much greater diameter than the circle which contains the axes of the tool spindles, so that even if there were looseness here, it would be diminished instead of multiplied at the tool point. In the same way, the locking of the spindle head takes place on a large diameter.

The form of tool-slide used (identical with that of the Gridley single spindle turret lathe) has also the advantage of allowing the use of multiple tools at the same station to take cuts on different diameters, for instance, or to turn and drill simultaneously.

Points of Interest in the Mechanism.

Referring to the description of the mechanism, it will be remembered that the rapid movement of the cam-shaft is driven from a constant speed pulley, while the feeding movement is derived from the pulley which drives the spindles. This is as it should be. The rapid movements invariably take place at the fastest speed possible, if the speed of pulley *G* is properly selected; and since the feeding movement is con-

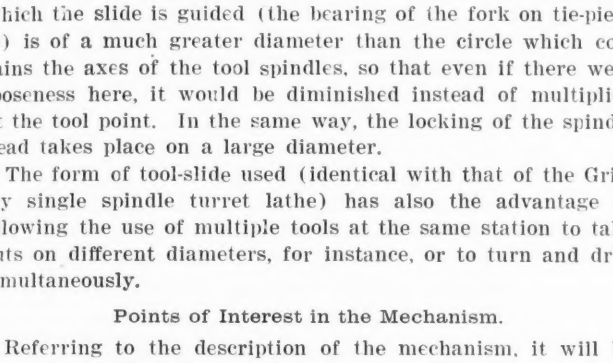


Fig. 6. Axial Section through Spindle Head and Spindle.

nected with the spindle, a given combination of gearing gives a definite feed in turns per inch, no matter what the speed of the spindle. This condition is the same as in the case of the lathe, and is the proper arrangement for any turning machine.

In the five months or more during which this machine has been in use, the value of the quick change mechanism for the feed has been steadily impressing itself on the minds of those who have used it. The machine may be set up with the tools properly adjusted for the work, without reference to the feeds; then, when the machine is started, the operator begins with a fine feed, gradually increasing it until the thickest chip is reached that the tool will stand. If a hard lot of steel is met with, the feed is lowered; if the tool appears to be taking it easy, the feed is increased. These adjustments would seldom be made if it were necessary each time to stop the machine and alter a set of change gears.

As previously noted, there are three cams furnished for the tool-slide movement, giving 2, 4 and 6 inches of travel respectively. There are two handles on the feed box. When the lower one of these is set in that one of its three positions which is marked to agree with the cam which is being used, the adjustment of the upper handle will give a certain definite range of feeds, *viz.:* 75, 100, 125, 150, 175 and 200 turns per inch. Other feeds can, of course, be obtained by using other combinations of handle position. These handles operate two shifting idler and gear cone mechanisms, arranged in series.

The threading mechanism is an attractive one. This operation is made entirely independent of the others, by the way

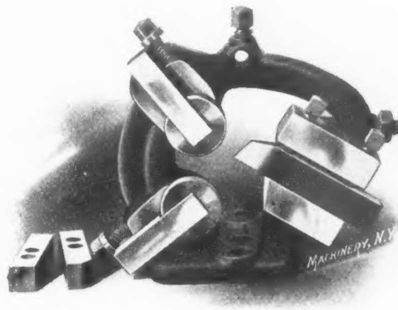


Fig. 7. Type of Turning Tool Used.

in which the die or tap is made to thread on or off by changing its feed relatively to that of the work, which remains unaltered. Left-handed tools are not required for turning and drilling operations, and the die has been threaded off by the time the other operations are completed, it not being necessary to wait for the return motion of the tool-slide to accomplish this.

Rigidity and Simplicity.

It will be seen that the central idea of the design of the head and tool-slide has resulted in a very rigid construction of the frame of the machine. (See Fig. 5.) The frame is all one piece, tied together at the top, so that all the strain of the feeding pressure is taken care of practically in simple tension, no bending action taking place. Above all, it should be noted, in this particular, that the bearing surfaces are free from cramping strains, the action of the feed-cam *M*, directly in back of the tool-slide, being an important item in this respect.

In the details of its mechanism, also, the machine has a noticeable simplicity and ruggedness. This is best seen in the rear view, Fig. 2. The members of the operating mechanism are strong, simple and few. There is nothing to get out of order, and everything is in sight. Strange to say, there are actually fewer parts in the tool than in one of the builders' single spindle machines.

The machine described above will take stock up to 1¼ inch in diameter, and will turn up to 6 inches in length. It weighs about 4,500 pounds.

MOTOR DRIVE MECHANISMS FOR LE BLOND LATHES AND MILLING MACHINES.

We show herewith a series of ten half-tone and line engravings, illustrating the solution of the motor drive problem for lathes and milling machines, arrived at by the R. K. Le Blond Machine Tool Co., 4605 Eastern Ave., Cincinnati, Ohio. These figures are particularly valuable as illustrating a consistent and systematic series of five designs, following the same general principles, but modified to suit the particular conditions under which they are used.

General Features of the Motor Drive Problem.

It is perhaps not necessary to say much about the comparative advantages of motor *versus* belt drive in connection with this line of machines, except as the general excellence of the design in this case enhances the points in which the motor drive appears to an advantage over its competitor. A greater number of speeds for a given range is obtainable with either the constant speed or variable speed motor drives than is ordinarily obtained by the cone pulley and back gear method. The advantage of this is evident. If it is not pos-

sible to run the work within 12 or 20 per cent of the speed at which the chip ought to be taken, it is evident that there is a waste of that amount constantly going on as long as the machine is in operation. There are also the well understood advantages of greater flexibility in arrangement of the machinery owing to the absence of line-shafts and counter-shafts; avoidance of transmission losses due to improperly designed and cared for belt and shaft transmissions; and avoidance of

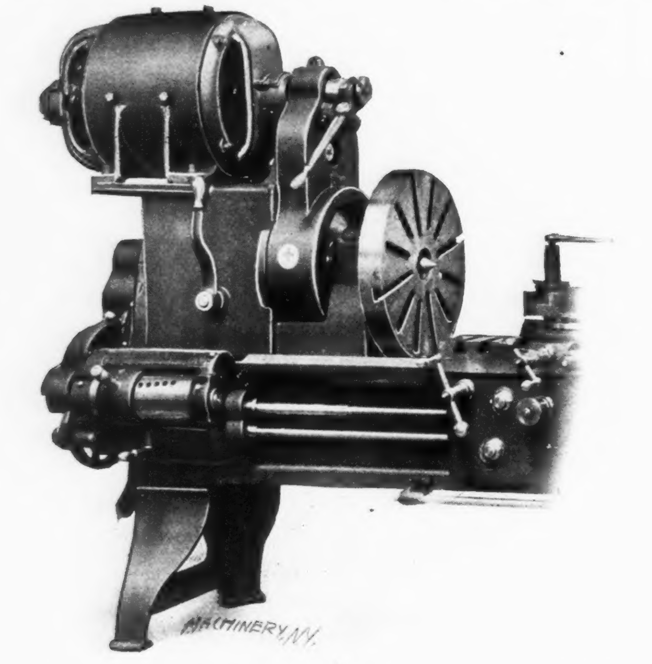


Fig. 1. Variable Speed Motor with Double Back Geared 20-inch Lathe.

the expense of running the whole system of shafts and belts for the sake of a comparatively few tools during slack times or long overtime work.

There are a number of factors entering into the design of motor drives for machine tools. There is, first of all, the question of the electrical system used—whether direct current single voltage, direct current multiple voltage, or alternating

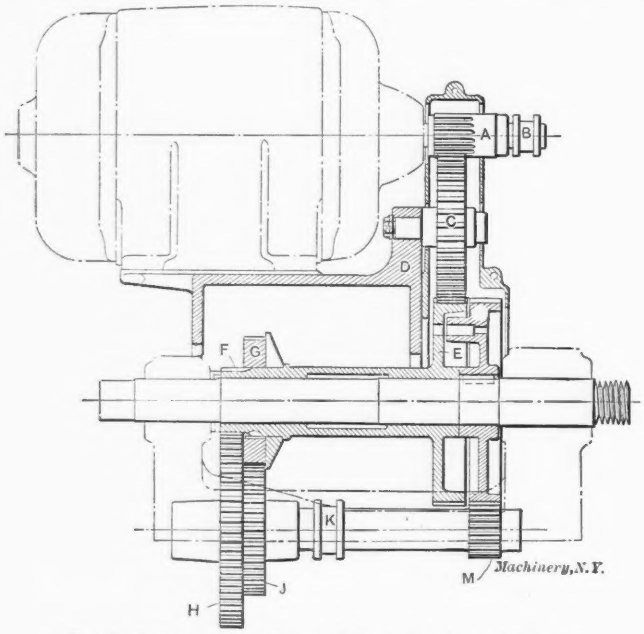


Fig. 2. Diagram of the Drive of the Lathe shown in Fig. 1.

current. With this matter, however, the machine tool designer has nothing to do, except as the system adopted requires the use of a constant speed or multiple speed motor. The arrangement of the gearing is vitally dependent on this question, as many more mechanical speed changes will have to be provided in the first case than in the second. Besides these electrical considerations, there are others which relate to the handiness, durability and efficiency of the mechanism. It should have as few parts as possible, consistent with the number of speeds it is desirable to furnish; changes should be quickly made without stopping the motor; the motion should be positive, and the parts should be strong and durable. In cases where a lot of mechanical changes are to be provided for, it is also an advantage to be able to change from one speed to another without going through all the intermediate steps. In other words, the control should be "selective."

Since provision is made in the Le Blond lathe for threading without reversing the spindle, no mechanical device for this is necessary. On the rare occasions when it might be necessary to run the spindle backward, the motor may be reversed, if electrical provisions are made for this. This simplifies the design greatly.

Lathe Driving Mechanism for Variable Speed Motor.

The problem evidently divides itself into two sections—those of providing mechanisms for variable speed, and constant speed motors, respectively. We will first consider the case of the variable speed motor. For lathes, the speed ratio should be from 40 to 1 up, depending on the size, if the lathe is to be used for the ordinary wide range of work. The most useful and satisfactory range of speed obtainable in variable speed motors is seldom much over $3\frac{1}{2}$ to 1; so for small and medium-sized lathes it is evidently necessary to provide three mechanically-obtained speeds, each about three and one-half

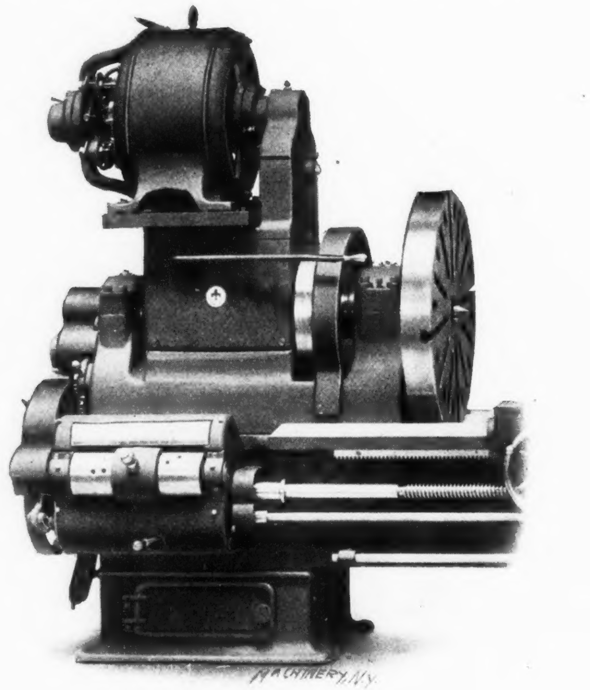


Fig. 3. Variable Speed Motor for 24-inch Lathe requiring Greater Speed Range than in the Case of Fig. 1.

times as rapid as its predecessor. This is done in the case of the 20-inch lathe shown in Fig. 1, by the driving mechanism shown diagrammatically in Fig. 2. The motor is mounted on a casing *D*, which surrounds the head-stock, and is bolted to it on each side. It is so arranged that practically no change has to be made in the head-stock from the form used for the ordinary cone-driven machine. It is only necessary to finish off the pads to which this casing is bolted. The back gear shaft and supports and other mechanism are unchanged, the back gear being shown below the spindle in Fig. 2 merely for clearness. In arranging casing *D* for different makes of motors, the upper part to which the motor is bolted may be readily changed to suit, or an adapter may be used here to connect the motor with the casing, as shown later in Fig. 4. No other alteration is necessary to fit the device to motors of different makes.

On the extended shaft of the motor is carried a driving pinion *A*, which is clutched to the armature shaft or released from it at will, by a clutch mechanism contained with it, operated by the lever shown in Fig. 1. This clutch, though compact, is very powerful, and is self-adjusting. It may be used for stopping the machine independently of the motor, serving the purpose of a belt shifter. Pinion *A* meshes with

a rawhide intermediate gear C, carried by a stud held in casing D. C drives a large gear E which is a part of a sleeve running loosely on the spindle, attachable to it at will through the main spindle driving gear and the usual lock bolt. This

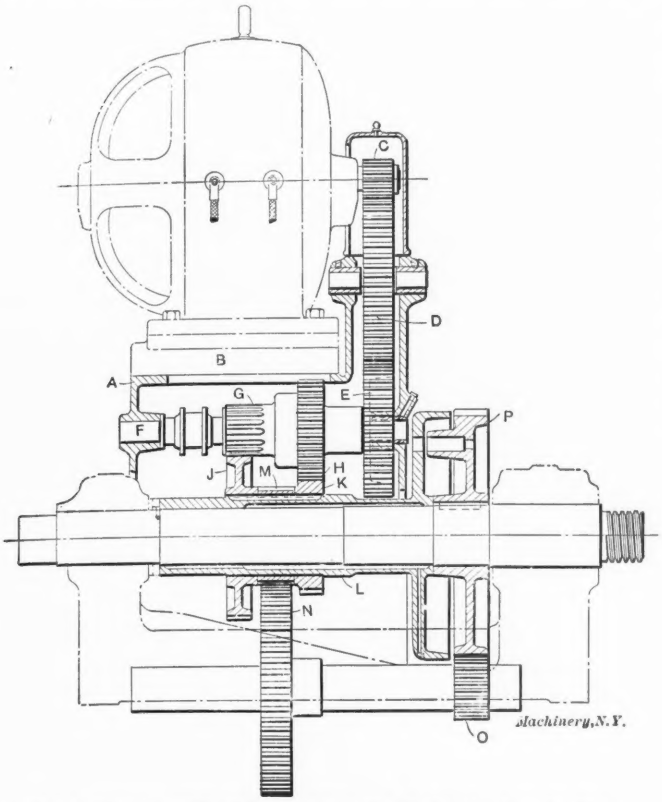


Fig. 4. Diagram of the Drive shown in Fig. 3, showing how the Four Mechanical Changes are obtained.

gives the highest speed. Two slower speeds are obtained through gears F and G, the former integral with the sleeve and the latter keyed to it. These mesh with gears H and J on the back gear quill, to which either one may be clutched by the vertical lever shown at the front of the head-stock.

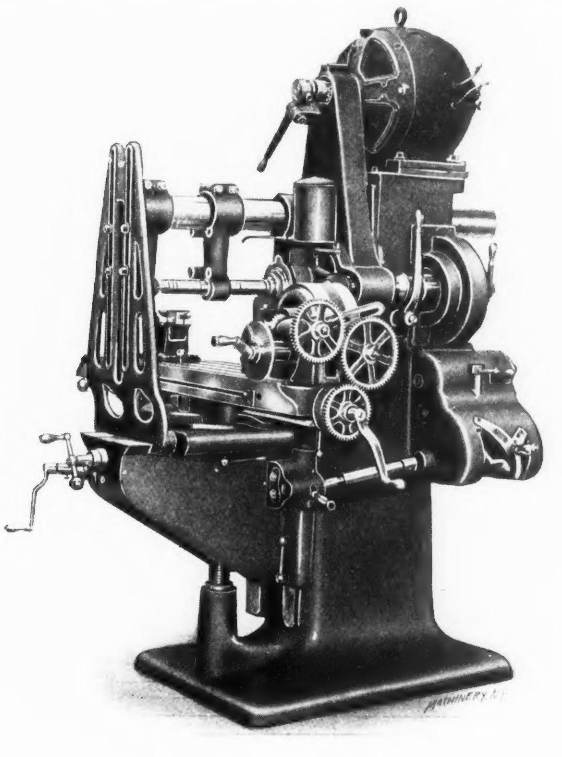


Fig. 5. Variable Speed Motor Drive for Milling Machine.

This lever shifts collar K, which operates a double friction of the well-known form used on the builders' double-feed lathe and millers. This design of clutch is simple, durable, strong and compact, and is self-adjusting. Pinion M, at the right of the back gear quill, meshes with the main spindle gear as usual. Three speeds are thus provided for, one direct from E when the bolt lock is engaged, and the other two through gears F or G when the back gears are used.

It will be seen that the mechanism is unusually simple, requires a minimum alteration from the old style belt and cone arrangement, and has the required flexibility in the matter of adapting itself to motors of various makes and sizes.

In Fig. 3 is shown a larger lathe, the 24-inch size in this case, in which the ratio of 40 to 1 is too small to cover the range of speeds desired. Four changes, each in about the ratio of 3.2 to 1 with its predecessor, have to be provided for in this case, giving a total range of 90 to 1 in the speeds, when a 3 to 1 variation is used for the motor.

The arrangement of the gearing will be understood by referring to Fig. 4. In this instance the motor is not directly mounted on the gear casing A, there being an adapting plate B between them whose lower surface fits the casing, and whose upper surface and thickness are altered to agree with the requirements of the motor. The driving pinion C is keyed directly to the motor shaft, since provision is made elsewhere

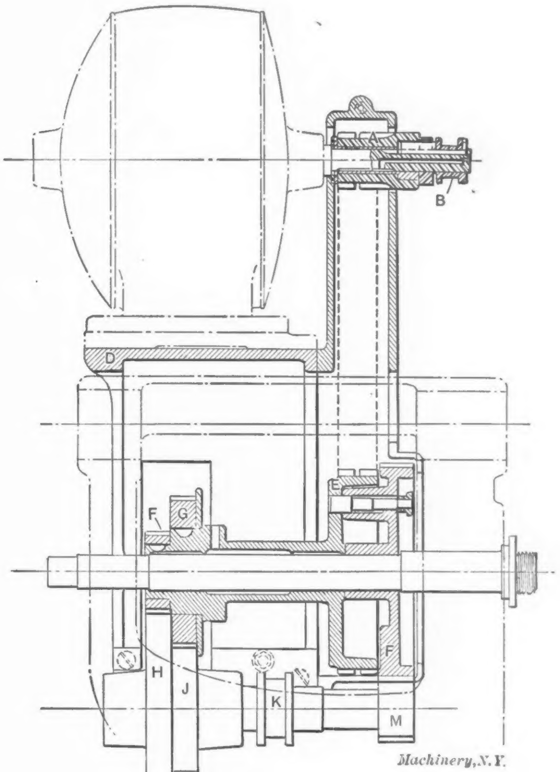


Fig. 6. Diagram of the Arrangement shown in Fig. 5. Compare with Fig. 2.

in the mechanism for disconnecting the drive without stopping the motor. Pinion C meshes with intermediate rawhide gear D as in the previous case, which in turn drives gear E, which is keyed to an intermediate shaft F, journaled at either end of the gear casing above the spindle.

The way in which the four speeds are obtained is readily seen. Sleeve L may be connected directly to the spindle by engaging the lock bolt in spindle gear P with the flange attached to the sleeve. When so connected, two speeds are available by shifting the horizontal clutch lever shown in Fig. 3, which engages either G or H with shaft F as may be desired. When sleeve L is free of spindle gear P and the back gearing is thrown in through M, N, O and P, there are two more speeds available, depending on whether G or H is clutched to shaft F. This gives four speeds in all. When the clutch lever is set on the central position, the motor is disconnected from the spindle. One advantage of this combination of double friction clutch and variable speed motor, is the fact that a total speed range of 9 to 1 can be obtained in 40 gradations, without stopping the lathe or shifting any positively acting connection.

Adapting the Miller to Variable Speed Motor Drive.

The problem of driving the milling machine from a variable speed motor is essentially the same as for the lathe. The only

changes in the conditions of the problem are those introduced by the interference of the over-hanging arm, which prevents the use of direct gearing between the motor and the spindle. The design adopted, shown in Figs. 5 and 6, should be compared with Figs. 1 and 2, the schemes being identical in every way. The change consists in connecting the motor spindle pinion *A* with the spindle sleeve gear *E* by a Morse chain instead of by an intermediate gear, otherwise the mechanism is the same. Similar reference letters refer to similar parts in Figs. 2 and 6. A casing *D* is fastened over the milling machine column in about the same way as it is for the lathe, very little change having to be made from the belt-driven arrangement. In the instance shown, an adapter is used between this casing and the motor. The back gear and motor pinion clutch lever are clearly shown in Fig. 5.

Lathe Driving Mechanism for Constant Speed Motors.

For the constant speed motor a much greater number of mechanical changes has to be provided than in the previous cases. The arrangement adopted for lathes by the builders is that shown in Figs. 7 and 8. The motor used in this particular case is of the alternating current type, though the

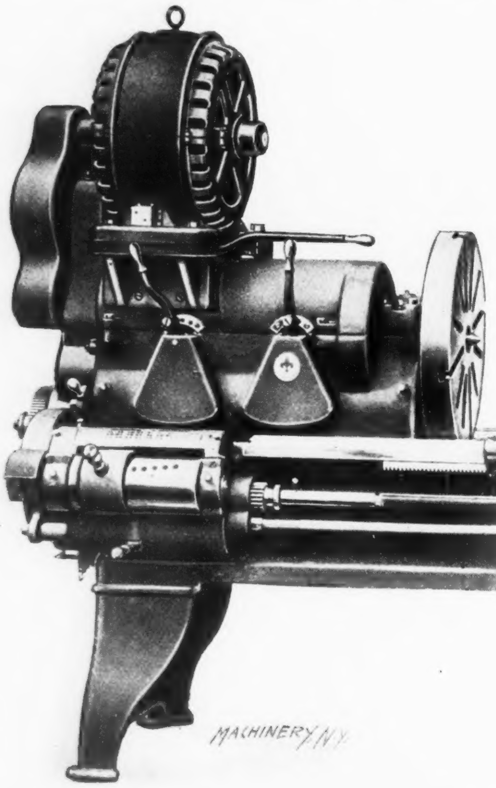


Fig. 7. Lathe driven by Constant Speed Motor, with Eighteen Mechanical Speed Changes.

mechanical arrangements would be the same of course with a direct current constant speed machine. The motor pinion *A* is connected to gear *C* on shaft *D* by an intermediate rawhide gear *B* (see Fig. 8). Either one of pinions *E* and *F* may be clutched to shaft *D* as required, so that sleeve *G*, which runs loosely in the spindle, may be driven at either of two speeds, through either *E* to *H*, or through *F* to *J*. Gears *K* and *L*, which form a unit, are keyed to the second intermediate shaft *M*, and may be shifted longitudinally so that *K* engages with *H* as shown, or so that *L* engages with *J*. Gears *Q*, *R* and *S* are all keyed to the lathe spindle. *Q* is permanently in mesh with gear *N*, which runs loosely on shaft *M*. Gears *O* and *P*, which form a unit, are keyed to shaft *M* and may be shifted longitudinally, so that *P* meshes with *S* as shown, or so that *O* meshes with *R*, or so that the clutch teeth on the face of *O* engage those on the face of *N*, thus connecting the spindle of shaft *M* to *N* and *O*.

It will thus be seen that twelve changes are obtained—two by the double clutch between pinions *E* and *F*, multiplied by two depending on the longitudinal position of gears *K* and *L*, multiplied by the three changes depending on the longitudinal position of gears *O* and *P*, giving twelve in all. The various operating levers are shown in Fig. 7. The horizontal lever operates the clutch for pinions *E* and *F*, and is used when in the central position for stopping the machine independently of the motor. The two vertical levers are for shifting the sliding gears, the one on the left operating *K* and *L* and the one on the right, *O* and *P*.

The machine shown in Fig. 7 has 18 changes, instead of the 12 shown in the diagram. This is effected by having a third

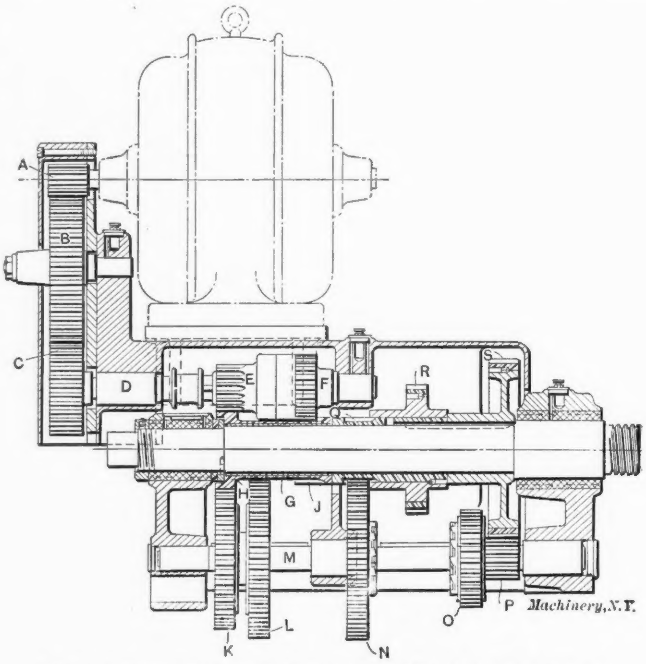


Fig. 8. Diagram of Drive Similar to that of Fig. 7, but giving only Twelve Speed Changes.

gear between *K* and *L* with a corresponding mate for it on sleeve *G*, thus adding six new speeds to the combination. For a 20-inch lathe, these 18 speeds give a total velocity ratio of about 30 to 1, ranging from 9.8 to 300 revolutions per minute in geometrical progression, having a uniform increment of 22½ per cent.

Constant Speed Motor Drive for the Miller.

This arrangement, modified to meet the conditions of the milling machine, is shown in Figs. 9 and 10. The arrangement of the gearing can be best understood from the line engraving. In this case the column of the machine is designed specially for the mechanism used instead of having it carried by an attached casing. This is necessary, as in Fig. 7, owing to the increased amount of mechanism required.

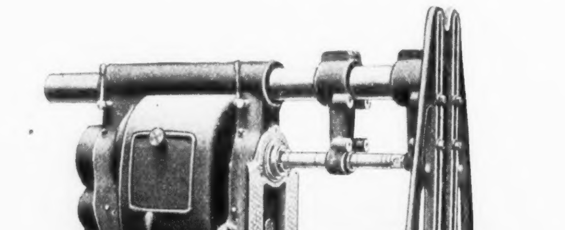


Fig. 9. Constant Speed Motor-driven Miller with Eighteen Speed Changes.

The motor is mounted on a bracket at the rear of the base of the column, the bracket being designed for the particular motor used, so as to bring the motor pinion *A* to the right position to mesh with the driving gear *C* on shaft *D*.

It will be seen that this arrangement corresponds to the 18-speed modification of the mechanism shown in Fig. 8. Similar gears and parts in Figs. 8 and 10 have the same reference letters.

The 18 speeds are obtained as follows: Two changes depend on the position of clutch fork *U*, which engages either one of pinions *E* and *F* to shaft *D*. These two speeds are multiplied by the three obtained from the three possible positions of sliding gears, *K*, *L* and *V*, which may be made to engage with either one of gears *H*, *J* and *W*. The six speeds thus obtained are multiplied by three, obtained from the three different positions possible for sliding gears *O* and *P*, which may be shifted so that *P* engages with *S*, *O* with *R*, or so that gear *N* meshing with *Q* is clutched to shaft *X*.

The arrangement shown in Figs. 7, 8, 9 and 10 is applicable to belt drive as well as to motor drive, the only change necessary being the substitution of a single speed pulley in place of the motor. This has the well-known advantages over the cone pulley drive of constant power at all speeds, and practically constant cutting pressure available at the point of the tool within the range of the lathe, whatever the diameter of the work. The ease of obtaining the changes is also

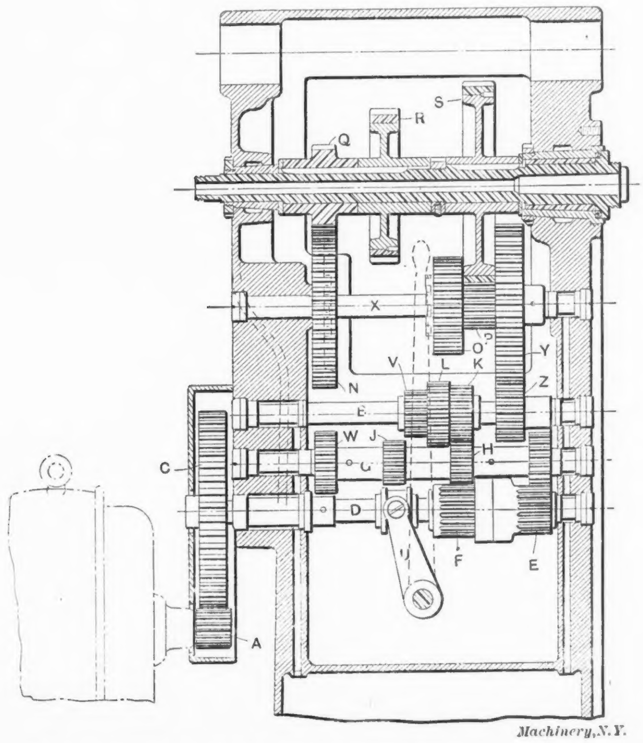


Fig. 10. Diagram of Spindle Drive of Milling Machine shown in Fig. 9.

a factor, especially when facing cuts are being taken, since the whole range is available without stopping the motor. With the liberal provision for speeds given there is also the advantage over the usual cone pulley arrangement in the smaller gradations in speed, and consequent greater efficiency of the machine as a whole.

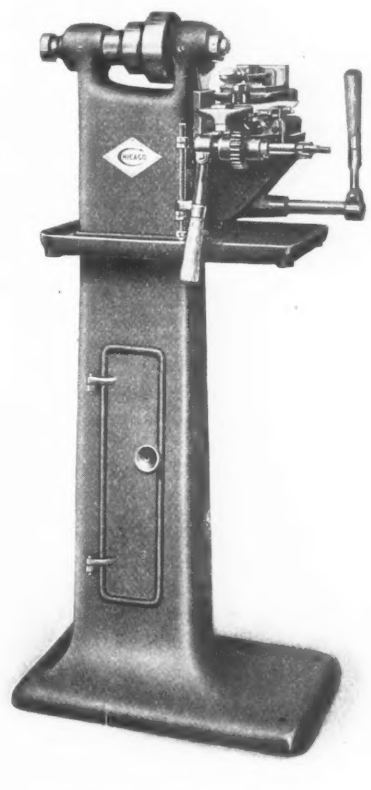
In these constant speed motor drives, both for lathes and millers, the gears are all of hardened steel. Those which are engaged by sliding have their teeth beveled for that purpose, as is the practice followed in automobile construction.

Suitable speed plates are provided for each case, with graphical representations of the position of the various levers used, and consecutive tables of the speeds corresponding with those positions. The use of the clutch lever in each of the above designs will be found particularly advantageous in stopping the machine. It avoids the necessity for stopping and starting the heavy, rapidly revolving armature every time it is desired to arrest the motion of the spindle. The whole problem seems to be worked out in a very logical and satisfactory way.

CHICAGO BENCH MILLER WITH COLUMN.

The well-known Chicago hand miller, made by the Chicago Machine Tool Co., of Chicago, Ill., is here shown adapted as a bench machine to the needs of manufacturers of such articles as guns, sewing machines, typewriters, locks, electrical and other work where short milling and slitting cuts are required in pieces of which large quantities are turned out.

The overhanging arm and vertical attachment supplied with the larger machine have been omitted; otherwise the design is about the same. The counter-shaft and the machine itself are equipped with dust-proof, self-oiling boxes, which require filling but once in nine months or thereabouts. This provision adds materially to the life and accuracy of the spindle. The machine may be mounted on the bench or on a special column provided for it, as shown in the engraving. The counter-shaft has two speeds, giving six spindle speeds to the machine.



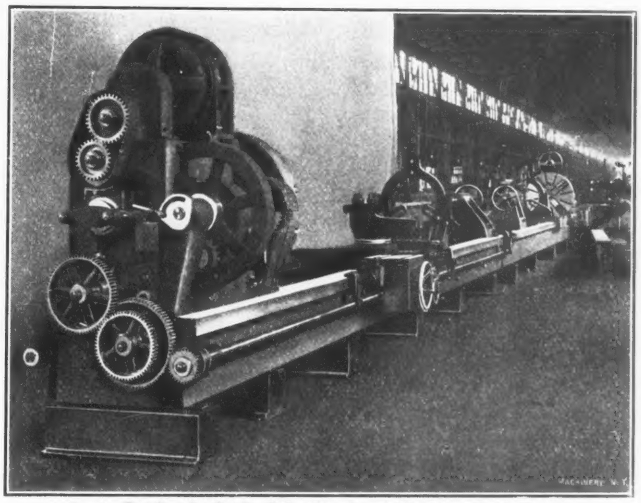
Chicago Bench Miller with Column.

The table feed is 9 inches, with a cross movement of 2½ inches. The vertical movement of the knee is 4¼ inches. The spindle is bored to No. 9 B. & S. taper, and is fitted with a sleeve to receive a draw-in collet.

Hill, Clarke & Co., Inc., Boston, Mass., are the agents for these machines.

LARGE SPECIAL POND LATHE.

The lathe shown in the accompanying cut is, as far as length goes, one of the largest ever built in this country. It is intended for turning long propeller shafts, and work of a



Large Duplex Lathe built by the Pond Machine Tool Works.

similar character, and is to be used at the Mare Island Navy Yard, for which it has been built by the Pond Machine Tool Works, Plainfield, N. J., branch of the Niles-Bement-Pond Co.

This lathe is designated as a 48-inch forge lathe, and is provided with two head-stocks, one mounted at each end of

the bed, and with two carriages and two tail-stocks, the latter normally placed at the middle of the bed, thus making in general two complete lathes. This duplex arrangement is plainly exhibited in the cut, where the heads, steady-rests, carriages and tail-stocks are shown in place. The bed of the machine is 77 feet long, and is made in three sections. The lead-screw on the one side of the machine not shown in the cut, runs for the full length of the bed, and is threaded for a length of 72 feet. On the side of the bed shown is another lead-screw, which, however, only runs half the length of the bed. The long lead-screw presents an interesting example in screw cutting. This screw was cut in an engine lathe. After turning and cutting the thread on a section of shafting, as long as could be handled in the longest lathe in the shop, a second section was welded onto the portion already finished, and then this portion was turned, and the thread cut on same. Several sections were thus welded on until the required length of lead-screw was obtained. The finished portion of the screw, while threading a new portion in this manner, was supported in a steady-rest, instead of being supported on the tail-center, as would have been the case with work that would not have been too long to be held between the centers in the lathe. The machine is driven by alternating-current motors, placed over the head-stocks, as shown in the cut.

THE ROCKFORD ROUTING MACHINE FOR KEY-SLOTS IN SPINDLE.

We show in Figs. 1 and 2 a novel and interesting adaptation of a 20-inch drill press, to the special work of routing the key-slots made in spindles, sleeves, etc., for forcing from their seats the taper shank of the various tools held in them. The drill press shown is one of the line manufactured by the Rockford Drilling Machine Co., of Rockford, Ill., and the re-arrangement of it for this special work was done in the shop of the builders for their own use.

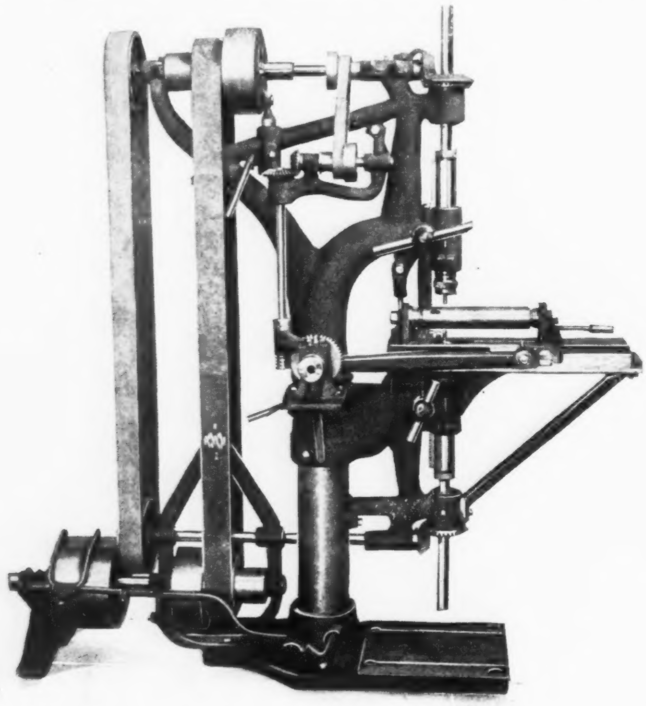


Fig. 1. Routing Machine for Key-slots, showing Table Reciprocating Mechanism.

A bed with longitudinal ways, supported by a brace, is used in place of the usual circular table. This bed carries a slide which is attached, as shown in Fig. 1, to a connecting-rod operated by an adjustable crank-pin in the face of a worm gear, carried by a bracket at the side of the column. This worm gear (through suitable belts, cones and bevel gears) is operated from the horizontal shaft at the top of the machine, as shown. By this means a continuous reciprocating movement of suitable length for the length of slot desired is given to the table. The work is held on the table by any suitable means. In the case shown, a pair of stepped centers are used, these being adapted to holding the various sleeves used in the line of drilling machines manufactured by the builders. Spindles and irregular work can be held in any suitable holders or fixtures.

The routing is done by rose or end mills, held in draw-in chucks in both of two spindles, one of which is the regular drill spindle of the machine, while the other is a supplementary one, in line with the main spindle, but below the table. This provision for two spindles and two mills allows the slot to be worked through from two sides at a time, thus increasing the output. The lower spindle is driven by bevel gears from a horizontal shaft, belted as shown to the horizontal shaft at the top, so that both spindles revolve at

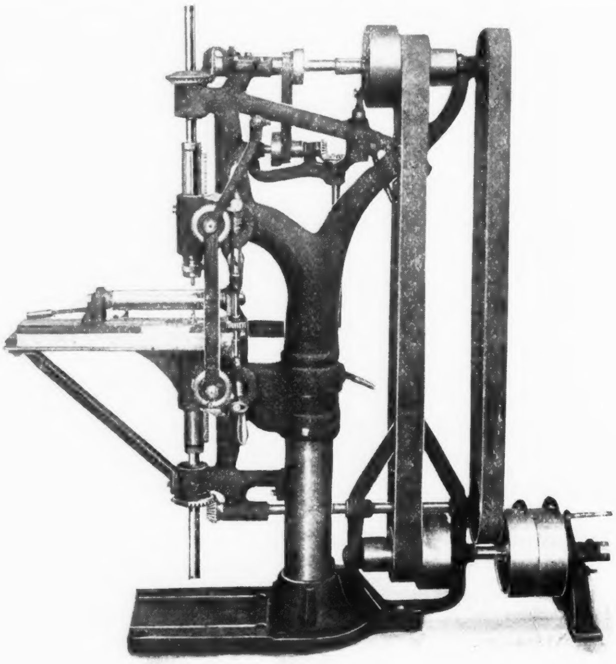


Fig. 2. Right Side of the Routing Machine, showing Feeding Motion for Mill Spindles.

the same speed, whatever the position of the driving belt on the cone pulleys. The driving mechanism has been strengthened throughout for the use of larger shafts and wider belts and pulley faces.

The feed mechanism is best seen in Fig. 2, which shows the other side of the machine. Each spindle is advanced by a rack and pinion arrangement as usual, operated by worm-wheels. The worm driving each worm-wheel is supported in a pivoted holder, and provided with a knock-out arrangement with automatic stop so that each spindle may be fed to depth and thrown out independently of the other. The vertical shaft which operates the feed worms through the universal joints is rotated by a ratchet mechanism, actuated by the reciprocating motion of the work slide.

The operation of the machine is now clear. The continuous rotation of the worm-driven crank, in Fig. 1, reciprocates the work through a stroke of the required length for the slot desired. At the end of each stroke the ratchet mechanism, in Fig. 2, operates the feed, sinking the mills a little deeper into the work at each reversal. This is continued until the slot has been entirely cut through into the center hole.

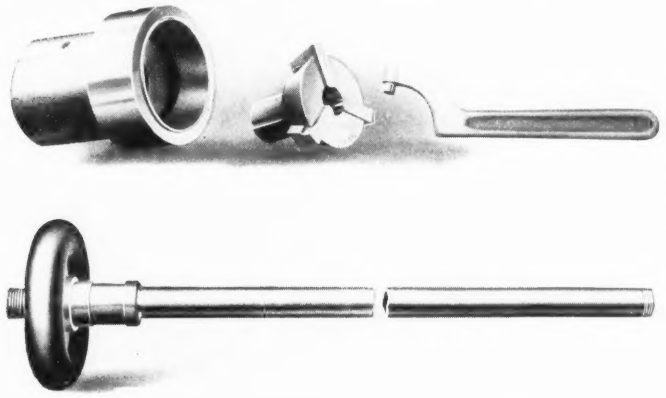
The machine is said to answer the purpose very well, doing the work accurately and quickly. It affords a distinct improvement both in quality and time, as compared to the old method of drilling a number of holes to form the slot, which is finished by chipping or broaching out the stock that is left. The arrangement shown was rather hastily designed for immediate use, but the builders are prepared to furnish it for the market in a more neatly designed form.

ADJUSTABLE COLLET WITH DRAW-IN ATTACHMENT.

In the accompanying cut we show an adaptation of the collet made by the Adjustable Collet Co., of Cleveland, Ohio, to the draw-in arrangement as used for spring chucks of the

usual construction. It consists, as may be seen, of a hood threaded directly to the nose of the lathe spindle, an adjustable collet fitted into the hood, and a threaded tube with hand wheel for tightening the collet on the work, from the rear end of the spindle. The directness of attachment of the device, with the carefulness with which it is fitted, insures the true running of the attachment.

The great advantage of this arrangement is the fact that it does away with the bother of changing from one size to



Adjustable Collet Co.'s Chuck with Draw-in Attachment.

another of the old-style draw-in spring collet, replacing a full set of them; the jaws of the adjustable collet grip any diameter of stock within its range. It may be provided with plain jaws for bar stock, or with step jaws for castings, collars, etc., and for stock that is larger in diameter than the passing capacity of the spindle. These tools are built to fit any size or make of lathe, of the engine, speed or turret design.

VAN NORMAN PLAIN MILLING MACHINE.

The Waltham Watch Tool Company, of Springfield, Mass., has recently added to its line of machine tools two milling machines of the plain manufacturing type. They have been placed on the market to meet the demand for accurately made, small manufacturing millers, such as are required in the interchangeable manufacture of sewing machines, typewriters, electrical apparatus, etc. Proper attention has been paid to the matter of giving them the stiffness required for using cutters of high speed steel, while at the same time sacrificing nothing in the way of ease and handiness in operation.

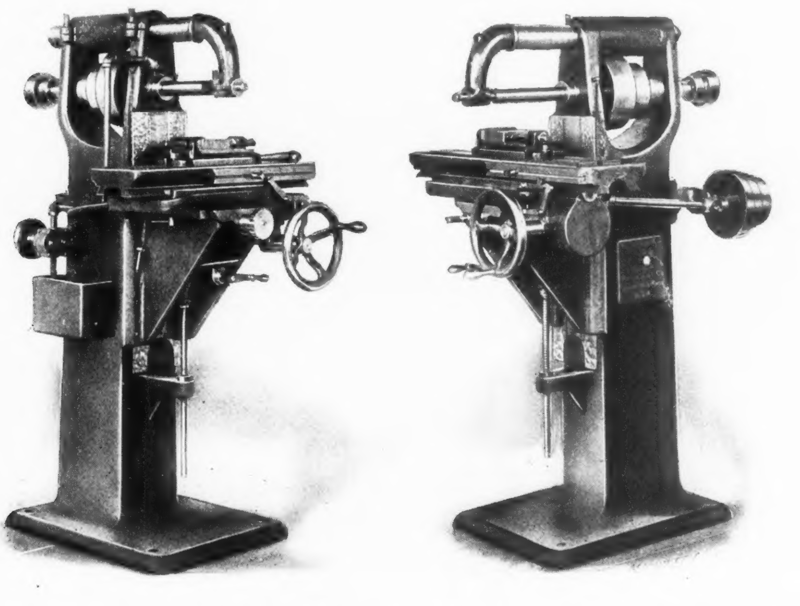


Fig. 1. No. A Van Norman Plain Milling Machine. Fig. 2. No. AA Machine of the Same Type.

The No. A machine, shown in Fig. 1, has a table with an automatic feed by means of a vertical rack and pinion, with a quick return operated by a conveniently placed hand wheel; this gives 3 inches table movement to a revolution of the wheel. The table of the No. AA machine (see Fig. 2) which is somewhat similar to that designed for No. A, but is of somewhat larger dimensions, is operated by means of a revolving nut and stationary screw. While feeding automatically, the screw is locked; when it is desired to stop it, the locking device on the screw can be instantly released, when the latter may be operated by hand. A quick return is furnished, as in the case of the smaller machine.

Attention is called to the design and fitting of the spindle. The bearings, both front and rear, are of cone form, and adjustment for wear is accomplished by one pair of take-up nuts at the rear. The spindle pulley is of ample diameter and width for the required driving power. The carriage and table are made with wide and long bearing surfaces, carefully fitted to insure rigidity. Ample provision is made for the use of oil in cutting operations, an oil tank with pump being attached at the side of the machine, while suitable channels in both table and carriage are furnished to return the oil after it has been applied to the cutter.

The feed of the table in the No. A machine is 13 inches. The table is 24 inches long by 7 inches wide. The spindle cone has three steps for a 2½-inch belt, the largest diameter being 7½ inches. The machine weighs about 850 pounds.

In the No. AA machine, the length of the feed is 18 inches, the area of the table 28 by 8 inches, the width of the belt 2¾ inches, and the largest diameter 8 inches. The weight of this machine is 950 pounds. In both cases the cross feed is 5 inches, and the vertical movement of the knee 14 inches.

NO. 3 WALKER SURFACE GRINDER.

We herewith show half-tones and line engravings descriptive of a surface grinder recently placed on the market by the Walker Grinder Co., of Worcester, Mass. The machine is intended for commercial work in the grinding of hardened steel, and soft stock as well, and can be used for roughing and finishing flat surfaces on castings and forgings of all kinds. It will thus be seen that it has a range of usefulness beyond the ordinary tool-room sphere to which the surface grinding machine is generally restricted. It is rigid enough to take cuts varying from 0.0005 inch or less up to 0.015 or 0.020 inch in depth, with a cross feed ranging from zero to 1/10 inch wide. The machine has three especially notable features—an adjustable tension belt drive, an improved method of guiding and supporting the sliding wheel column, and a new noiseless friction clutch reversing mechanism. These and other interesting details will be understood after a study of the accompanying engravings and descriptive matter.

The base of the grinder is of the usual T form; one section of it supports the bed for the work table, while the rearward extension carries a base on which the wheel housing slides. These two parts of the bed are made separate in order to provide for the extended bearing of the wheel housing, which is a feature of the machine. The wheel column bed *B* (see Figs. 2 and 3) has projecting horns, carrying the guiding surfaces on its top in through an opening in the side of the work table bed *C*. The wheel column *E* also has its ways extended on the front of projecting horns, which enter the same opening in bed *C* and bear on the extended guides of *B*. It will thus be seen that the wheel *D* has a support directly under it throughout practically the whole range of its cross travel. The two parts, *B* and *C*, of the bed are tied together by a bolt *G* as shown, which thus makes the base one solid casting, so far as vibration is concerned.

Column *E*, wheel slide *F*, and the wheel with the attached parts, together weigh something over 300 pounds, which is much more than sufficient for the heaviest feed that could possibly be borne by the wheel. Since it is thus possible to depend on the weight of the column, the ways provided for

it on base *B* are of the V type, commonly used for lathe carriages.

The movement of the column is controlled by cross feed screw *T*, operated by a hand-wheel at the front of the bed. The gear driving the table rack, and some parts of the reversing mechanisms are pivoted about the axis of the screw *T*, but they are entirely separate from it. The wheel slide *F* is guided on sliding surfaces within the double column. It is adjusted vertically by the hand-wheel *H*, which may be

Fig. 1. The Walker Surface Grinder.

swiveled to any convenient angle to suit the position of the operator. Being counterweighted, there is no danger of its dropping down against the slack of the vertical adjusting screw. This also makes it as easy to raise the slide as to lower it, the motion being equally free in each direction. The wheel spindle is hardened and ground, and runs in hard bronze ring-oiling boxes, adjustable for wear. The end play is taken up by an adjustable cap at the rear of the spindle.

The arrangement of the belt drive can be followed from line drawing Fig. 3, and the rear view of the machine, Fig. 2. Drum *A* at the base of the machine is connected with the counter-shaft by the pulley and belt shown, and drives a belt *J*, which passes up over a pulley at the top of the wheel column and down around the driving pulley *K* on the spindle. (See the small detail at the left of Fig. 3.) From here the belt passes up over an idler *L* in the wheel slide, and back down to the drum again. It will be noted that the belt enters and leaves pulleys *K* and *L* vertically, so that there is no disturbance in the tension of the belt as the slide is moved up or down. Pulley *M* at the top of the column is carried by a slide, adjustable vertically by a screw and slide for maintaining the proper tension of the belt. As about 5 or 6 inches of stretch are provided for, an endless belt may be used, which will not need re-cementing until after long continued use.

The work table *N* is provided with liberal guiding surfaces, and has a roll oiling device which is identical with the standard arrangement applied to planer ways. The table receives its reciprocating movement from a rack and gear in the same way as does a planer. This gearing is connected to a pair of friction clutches, contained within the forward and reverse driving pulleys seen at the left of the machine in Fig. 1. The friction clutches contained within these pulleys are of durable construction, with a large area of contact surface, and are very simply constructed as well. By the use of a screw driver and wrench, they may be easily adjusted when adjustment is required, yet not so easily that they will be constantly tampered with by an unskilled operator. The use of friction clutches in place of the usual positive toothed clutches for driving the table, is considered by the builder to be a great improvement. The reversal is effected accurately, but with an entire absence of the shock noticeable with the older arrangment.

Reversing dogs *O* and *O* (see Fig. 4) are clamped in a T slot on the front of the table. These dogs engage the upper end of reversing lever *P*, whose lower end carries a roller operating the spring plunger *Q*, of the usual design in such mechanisms, whose function is to prevent the reversing lever from stopping on dead center. As lever *P* is thrown over alternately in each direction, it strikes contact screws on swinging bar *R* which operates clutch lever *S*. This latter is directly connected with the clutch mechanism. The table movement may be manually operated by the crank and pinion shaft at the left side of the base. The pinions are slipped out of engagement when the hand movement is not in use. Reversing dogs *O* may be thrown out of the way when desired, to allow the tool to run beyond its regular movement without altering their adjustment.

An automatic cross feed is provided, acting on screw *T*. Reversing lever *P* is connected by a link as shown to toothed sector *U*. This link may be adjusted in the slots of both *P* and *U* (as shown only in Fig. 1) to vary the amount of swinging movement given to the latter as each reverse movement takes place. This adjustment serves to vary the automatic cross feed. Sector *U* meshes with a pinion rotating the feed crank *V*, which thus receives a movement of con-

Fig. 2. Rear View of the Grinder, showing Extension of Wheel Column Ways under Work Table.

siderable amplitude on either side of the dead center, so that the connecting-rod *W*, to which it is attached, is given a forward and backward movement at each reversal. This connecting-rod has rack teeth cut in it, engaging with a pinion *X* (see Fig. 3) operating the ratchet feed mechanism of the cross feed screw. The ratchet may be made to feed either in or out, by shifting the operating pawl in the same way as is customary for planer feed mechanisms.

Means are provided for stopping the reciprocating movement of the work table at any point in the automatic cross

feed. The upper end of clutch lever *S* carries a projecting arm, so shaped as to engage with an abutment on stop lever *Y*. This lever is normally held in its upward position by the support of a collar on stop rod *Z*; this stop rod can be operated by adjustable dogs on the wheel column *E*. When the column has reached the desired point in the cross movement, given by the automatic cross feed, the adjustable

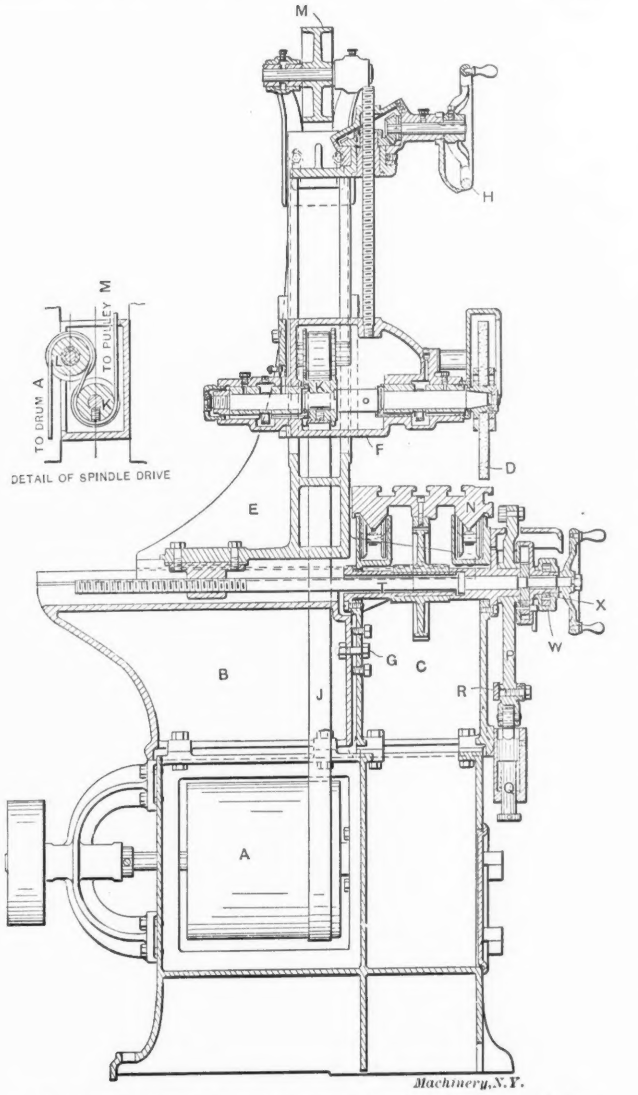


Fig. 3. Vertical Section showing General Design of Walker Grinder.

dog shifts stop rod *Z*, allowing stop lever *Y* to drop from its position on the collar until its abutment rests on the upper end of reversing lever *S*. As the next reversal takes place, the two engaging surfaces of *Y* and *S* strike, stopping the movement of *S* in mid-position where both of the friction clutches are disengaged, so that the movement of the table is arrested. The adjustable dogs on the wheel column which

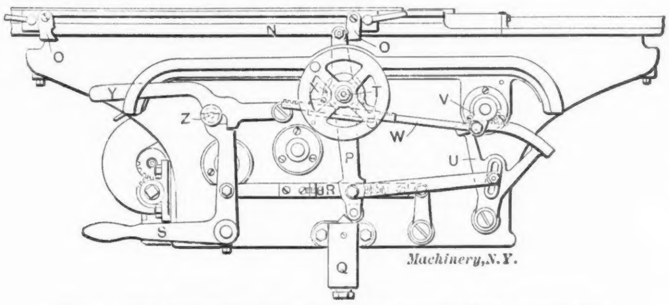


Fig. 4. The Reversing and Automatic Cross-feeding Mechanism.

govern this movement are so arranged as to be positively operative, at the extremes of travel of the cross movement, so that there is no danger of the power feed being forced beyond the range of movement provided. This avoids the possibility of damage to the mechanism from this cause.

Three speeds are provided for the grinding wheel, obtained from a pair of cones in the overhead works. It is thought best to place the speed change here, since the only reason for altering it is to accommodate the change in diameter of the wheels as they wear down. If the speed change is made too easy, there would be danger of the operators experimenting with it after it had been set for the proper rate. It can still be easily changed when there is really need for it.

The machine is arranged to carry grinding wheels 10 inches in diameter and ⅝ inch wide. The grinder can be furnished with a magnetic chuck built integrally with the platen, or if desired, a special magnetic chuck 26½ inches long can be used. The grinder can also be provided with an individual exhausting system for the dust, and can be arranged for motor drive if the purchaser desires. The length of the stroke of the table is 30 inches, the cross feed is 8 inches, and the vertical adjustment is 10½ inches. The net weight of the tool is about 1,700 pounds.

D'AMOUR SENSITIVE DRILL PRESS.

This little tool, shown in the accompanying half-tone as a bench machine, may also be furnished with a column for use on the floor. It is built by the Charles Ramsey Company, 135th Street and Willow Avenue, New York. The spindle is of open hearth steel and is entirely relieved of belting strain, besides being counterbalanced by a weight inside of the frame, making it extremely sensitive to the touch. It is also provided with means for taking up wear and lost motion. The feed is by rack and pinion. The adjustable stop is of new design, applied directly to the pinion instead of to the top of the spindle, thus doing away with the tendency to spring the frame of the machine, making it possible to drill or counterbore more nearly to exact depth.

D'Amour Drill Press arranged as a Bench Machine.

The spindle is driven by either of two speeds, obtained from the cone pulleys shown. The countershaft pulleys are carried by a bracket which has vertical adjustment, and acts as a belt tightener. An endless belt is provided for the machine. The fact that the counter-shaft is attached to the machine makes the trouble and expense of properly installing it very small. The spindle and countershaft pulleys are of unusually large diameter, giving greater belt speed and a more powerful drive than is usual with drills of this size and type.

The greatest distance from the spindle to the table is 8 inches, and from the center of the spindle to the frame, 6 inches. The table has a vertical adjustment of 5 inches, that of the spindle is 2 inches. The drill capacity of the machine is from zero to 5/16 inch diameter. The weight without column is 60 pounds; with column, 120 pounds.

MANVILLE CAM CUTTING MACHINE.

It has always seemed strange that no machine tool has been placed on the market, carefully and consistently designed for the purpose of making cams, one of the commonest and most vital machine parts used in a wide range of automatic machinery. The various forms of cams have almost invariably been cut on attachments to the lathe or milling machine. Many of these attachments are very ingenious, and work in a way that is quite satisfactory, but they have the lack of convenience and productive power that almost invariably at-

tends the use of such special contrivances. Barring a machine for cylindrical cams which was built some years ago and had a comparatively limited sale, the one we illustrate in Figs. 1 to 4 is, so far as we know, the first distinctive cam cutting machine to be placed on the market. Its construction is rigid and convenient, and ingenious enough to repay a study of the half-tones and line engravings we show herewith.

As may be seen, the machine consists essentially of a bed on which are mounted two heads—one for the cam and one for the former—while between them is mounted a spindle on a swinging frame, one end of which carries the former roll, while the other carries the cutter which does the milling. It will be seen that the machine is for the variety of cams known as plate cams, in which the guiding surface is formed on the outer periphery of the disk. It will also, of course, form what are known as face cams, in which a cam slot is milled in the face of a disk. These two forms constitute by far the larger part of the cams in common use. The only other type frequently met with being the barrel or cylindrical variety.

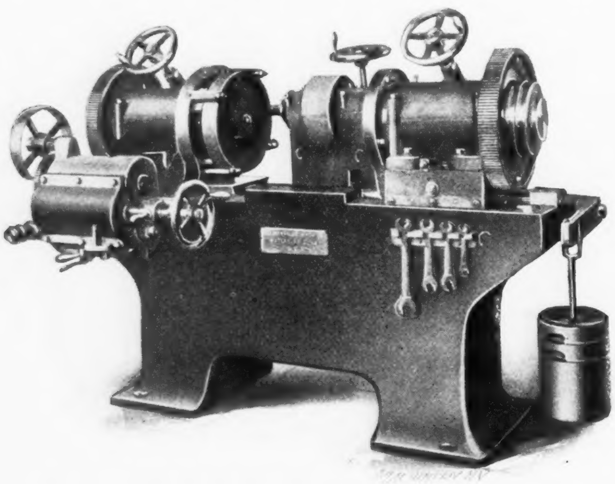


Fig. 1. The Manville Machine for cutting Plate and Face Cams.

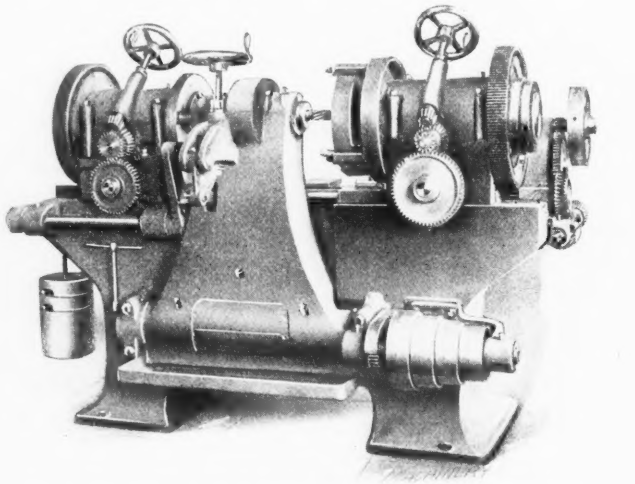


Fig. 2. Rear View of Cam Cutting Machine, showing Spindle and Forming Roll Support.

Head-stock *A* (see Figs. 3 and 4) carries a heavy face-plate to which the work is clamped. This face-plate is cast solid with a rugged, large diameter spindle, which carries the driving head at its rear end. Similarly, foot-stock *C*, which has also a limited adjustment on the bed, has a face-plate for the former or master cam, and is driven by gear *D*. Both *B* and *D* mesh with pinions on driving shaft *E*, which runs the length of the bed and rotates the two face-plates in unison. It receives its motion through the quick change gear mechanism shown, giving a suitable range of feeds, which can be quickly altered to suit the changed conditions as the mill approaches the center or recedes from it. This feed may be thrown out instantly, or reversed as well, all the controlling handles being within easy reach. It may be manually operated by hand-wheel *F*. Driving gears *B* and *D* are split, and may be adjusted to take up all back lash, so that assurance is given that the work and the former revolve in absolute unison.

The swinging frame *G*, which carries the mill *H* and the forming roll *J*, is pivoted at the back of the machine near the base, and is normally under the influence of weight *K*, acting through rock shaft *L* and arm *M*, so that the former roll *J* is pressed firmly down against the periphery of the forming cam on the face-plate of tail-stock *C*. As this forming cam revolves, it is evident that frame *G* will swing in and out, giving mill *H* the proper motion to duplicate in the work the contour of the former. The mill is driven from cone pulley *N* through the bevel gears and the vertical shaft *O*, contained within the swinging frame *G*. The various speeds provided by the cone pulley, and the provision for reversing the movement, gives a wide range of adaptability to different sizes and designs of milling cutters.

Hand-wheel *P*, mounted on the back of the swinging frame, acts through the worm and worm sector *Q* on a pivoted bar *T*, which is notched to bear against a pin in *Q*. When this pin is in the notch and the hand-wheel is rotated in the direction shown, the pressure of *Q* against *T* forces the frame

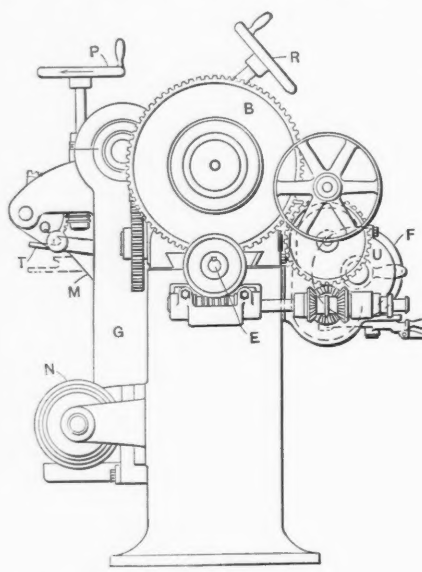


Fig. 3. End View of Machine.

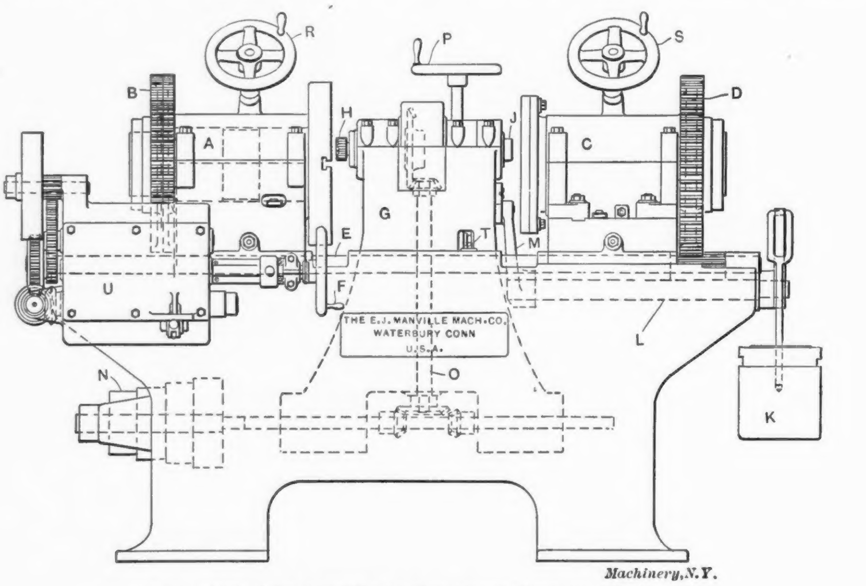


Fig. 4. Front View, showing Driving Connections for Spindle and Rotary Feed Motion.

G back, lifting the weight and raising the roller *J* from the former. This provision is made for changing the work, removing the cutter and for similar adjustments. When hand-wheel *P* is rotated in the other direction and the roll is again brought back to the former, the continued movement of the hand-wheel withdraws the pin in *Q* from the notch in *T*, allowing the latter to drop to the position shown by the dotted lines. The frame is then absolutely free to follow the contour of the forming cam under the influence of the weight.

When it is desired again to raise it from the work, bar *T* is brought into position by hand, easily done from the front of the machine, while the hand-wheel is operated as before.

The convenience of the arrangement of the machine will at once be appreciated. The longitudinal adjustment of heads *A* and *C* can be effected from the front by hand-wheels *R* and *S*. These heads are firmly clamped in their position by handles projecting from the front of the machine. Hand-wheel *R* is used, of course, in feeding the mill *H* to depth when cutting face cams. If desired, it is possible to follow an outline scribed on a cam without using a former at all. Under such conditions, swinging bar *T* is thrown into engagement with the pin in *Q*, and hand-wheel P is used to feed the mill out or in, in following the contour, while the work is revolved by the left hand, controlling hand-wheel *F*. Provision thus seems to have been made for about all the requirements likely to be met with in a machine for this work. The stiffness and cutting power of the machine should evidently be considerable, to judge from the general design, and the swinging member is so rugged, and supported so firmly, that all rocking and twisting strains are avoided. This stiffness and rigidity result from the use of separate spindles for the work and former, and the placing of the milling cutter and forming roll between them.

The machine is built by the E. J. Manville Machine Co., of Waterbury, Conn. It is the result of the requirements of their own business, which includes the designing and building of automatic machinery of all kinds, particularly that for bending wire into intricate shapes. Such machinery is largely dependent on the use of cams. To indicate the applicability of cam driving mechanism for such machinery, mention may be made of that used in making the well-known De Long hook and eye, built by this firm. The cams of this machine are run at the rate of 250 revolutions per minute, producing 250 perfect hooks per minute. These same machines were operated at a speed above 300 per minute, but at this rate it was found necessary to use an air blast to assist the finished product in dropping from the machine fast enough to prevent it from clogging up.

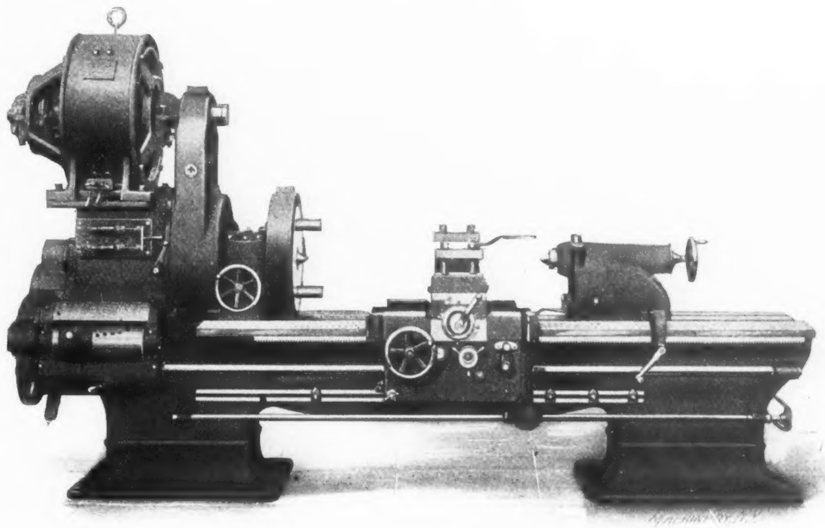
LE BLOND HIGH-SPEED ENGINE AND REDUCING LATHE.

Two new modifications of their regular design of engine lathes have been developed by the R. K. LeBlond Machine Tool Co., 4605 Eastern Avenue, Cincinnati, Ohio. The change consists in re-designing the bed, head-stock, foot-stock, and carriage to withstand the greater strains they are expected to carry, and involves a corresponding re-designing of the spindle drive and feed mechanism.

For the belt-driven, high-speed engine lathe, a 3-step cone pulley is provided for a $5\frac{1}{2}$-inch belt. This cone may be connected directly with the spindle, or geared to it through quadruple back gearing, from which two changes are obtained by the regular LeBlond double friction back gear, while the other two changes are obtained by the endwise shifting of a double pinion on the back gear shaft, which may be made to engage with either the spindle gear or with teeth on the periphery of the face-plate. When a double speed counter-shaft is used, 30 speeds are thus provided for, ranging from 7.6 to 250 revolutions per minute. With the reducing lathe, the drive is practically the same, except that the machine is always back-geared, and the double-speed counter-shaft is not required. This gives 12 speeds, ranging from 11.2 to 143 revolutions per minute. The reducing lathe is especially designed for heavy cuts in steel castings and forgings.

When the machine is motor driven, a variable speed motor is used, mounted as shown in the illustration, which represents the reducing lathe. The controller is operated from a handle on the carriage, connected by gearing, chain and sprocket with the controller shaft at the back of the machine. The motor may be stopped and started by this handle, or the machine may be stopped and started independently of the heavy, rapidly revolving armature shaft by the friction clutch provided between the armature shaft and the driving pinion mounted on it.

The apron on this lathe has steel gears throughout, is of a semi-box construction in which all the shafts and studs are supported at both ends. The rear bearing acts as a rib, to connect the ends of the apron. The tail-stock is of improved design, reinforced to withstand heavy strains, with improved and effective methods of clamping the spindle to the body, and the body to the bed. The turning and screw cutting feeds are



Le Blond Motor-driven High speed Reducing Lathe.

obtained by the standard Le Blond quick change device, giving 33 threads and feeds, including the $11\frac{1}{2}$ pipe thread, without removing a gear. The range of threads is from 1 to 24, and the feeds are four times the threads. A series of stops are provided in the T-slot at the front of the bed behind the apron. These may be set for the shoulders on the work, so they will stop the carriage successively as each point is reached.

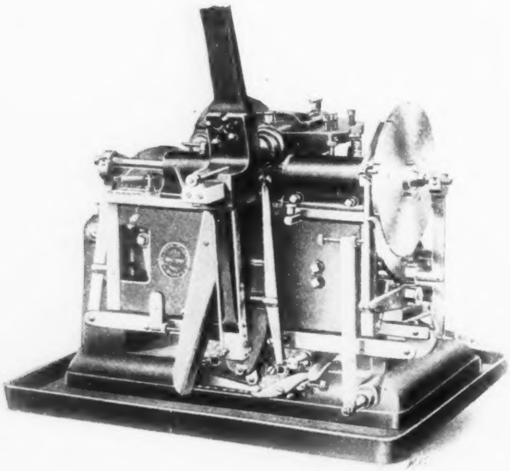
The engine lathe is provided with compound rest and power angular feed. The reducing lathe is ordinarily provided with a carriage of special construction, in which the lead-screw and threading mechanism are omitted, and double tool-posts are provided, one in front of the work and one in back, so that a double chip may be used for great reductions in diameter. The strong spindle drive and feed connections permit the removal of great quantities of chips by this method.

WALTHAM AUTOMATIC PRECISION GEAR AND PINION CUTTER.

We illustrate in the accompanying half-tone a highly developed form of automatic gear and pinion cutter, intended for small work on gears such as are used in instruments, typewriters, clocks, recording devices, etc. An especially interesting feature of the machine is the magazine feed provided for pinion blanks. When this is used, the machine is entirely automatic in all its movements. At the conclusion of the last cut on the work the holding centers are separated, the cut pinion ejected, a new blank is brought by the carrier from the magazine to the centers, the centers are clamped to the blank, and the cutter is again brought into position to take its first cut on the new work.

Provision is made in this machine for taking either one, two or three cuts through each tooth space. The cutter spindle is lifted while the return stroke of the work slide is being made, thus allowing the indexing to be done without loss of time, and preventing damage to the cutter dragging back through it. The stroke of the work slide is adjustable, and the head- and foot-stocks can be shifted so that either long or short work can be accommodated. When

used as a hand-fed machine, the magazine is removed. The machine is then adapted to the cutting of small gears in stacks, as well as to the cutting of pinions.

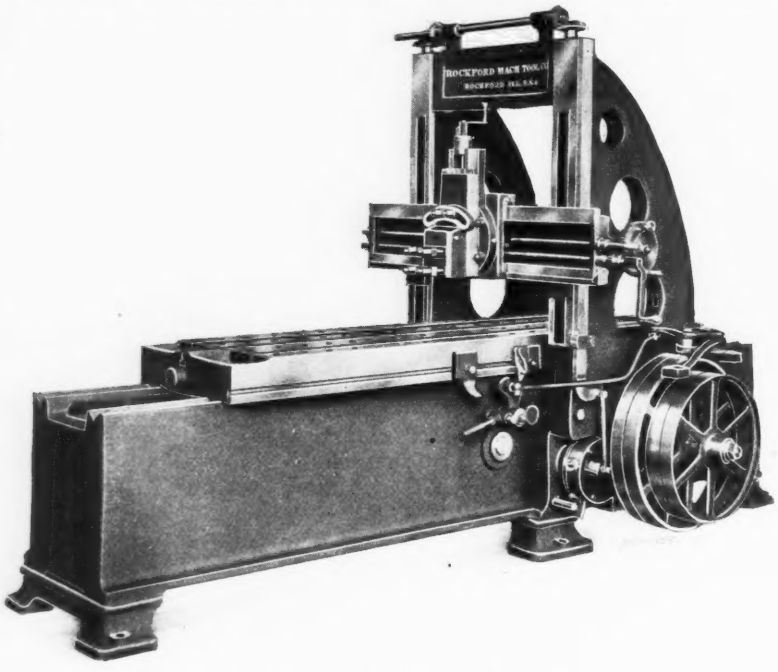


A Precision Gear or Pinion Cutter in which the Work may be automatically fed to the Machine.

This tool is built by the Waltham Machine Works, Waltham, Mass., and is similar to the smaller size shown on page 361, (Engineering edition) of this same issue, that one being also a three-cut machine.

ROCKFORD HEAVY PATTERN PLANER.

The accompanying half-tone shows the first of a new line of heavy pattern planers which the Rockford Machine Tool Co., of Rockford, Ill., is bringing out. The machine shown has a capacity for work 24 inches wide by 24 inches high, and has a 6-foot bed. Among the salient features of the machine is double gearing inside of the bed for transmitting the motion from the pulley shaft (which carries two pinions) through two intermediate gears, one each side of the bull wheel, to the large pinion which drives the latter. This feature ensures long life, and gives great power to the machine. All the gears in the drive are inside the bed, between the bearings, so they are protected from accident and falling

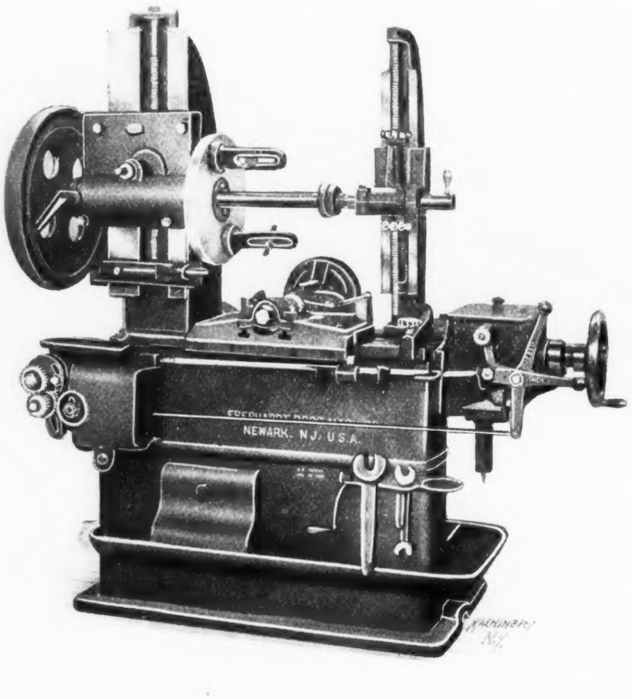


The Rockford Heavy Pattern Planer.

chips. All the bearings in the bed are bored and bushed and fitted with efficient self-oiling devices. The feed friction is of the double releasing type, and will not heat even when on short stroke, though furnishing a powerful feed to the tool when taking heavy cuts. The feed range is from 0.016 inch to 0.750 inch per stroke. At a cutting speed of 30 feet per minute, the drive is so proportioned that the return of the platen is 95 feet per minute. The machine weighs 7,100 pounds.

EBERHARDT BROS. NO. 3 AUTOMATIC GEAR-CUTTER.

The accompanying half-tone shows the new No. 3 size of the line of automatic gear-cutting machines built by Eberhardt Bros. Machine Co., 66 Union St., Newark, N. J. This new size has a capacity for work 36 inches in diameter and



A New Member of the Eberhardt Bros.' Line of Automatic Spur Gear Cutters.

10 inches face. It will cut 4 diametral pitch in cast iron (or 5 diametral pitch in steel) in one cut at a fast rate of feed. It will, of course, cut larger teeth if a stocking cut is taken first.

The mechanism of this machine, which is designed for cutting spur gears only, is similar to the rest of the line brought out by this firm, embodying the positive indexing mechanism, the spur gear drive for the cutting spindle, the long cutter carriage with the spindle in the center of its length, and the provision for putting the feed screw under tension instead of under compression during the cutting action. It will be noticed that the 10-inch width of face which is within the capacity of the machine, is unusually long, allowing several gears to be cut at a time. This is made possible by the design of the machine, which permits the cutter slide to run past the column to some extent, thus adding considerable to the effective feed of the cutter.

A convenient feature is the arrangement of the controlling handles. These are all on the front side, or near the hand-wheel at the end of the machine, so that the operator, in setting, has control of all the movements without changing his position. The hand-wheel has a clutch and spring to keep it automatically disengaged during the running of the machine.

The equipment regularly furnished includes an indicator for setting the cutter central, change gears for cutting all numbers of teeth from 10 to 100, and all from 100 to 400, excepting prime numbers, and many higher numbers, change gears for feed and speed changes, face-plate with jacks and drivers for fastening and driving the work, a work arbor with collars and stepped flanges, a cutter arbor of the removable type, oil cup and fittings, and counter-shaft. The counter-shaft is of the tight and loose pulley pattern, and is

ring oiling, special provision being made for lubricating the loose pulley bushing. Other members of this line of gear cutters were illustrated in the November, 1906, and the June, 1907, issues of MACHINERY.

NEW LINE OF HEAVY NEW HAVEN LATHES.

In Fig. 1 is shown an example of one of a line of heavy pattern engine lathes which the New Haven Mfg. Co., of New Haven, Conn., is placing on the market. Aside from the general strength of the design, of which considerable may be understood from a study of the engraving, there are a number of interesting points connected with the details of the mechanism, particularly with reference to the feed changing device and the taper turning attachment.

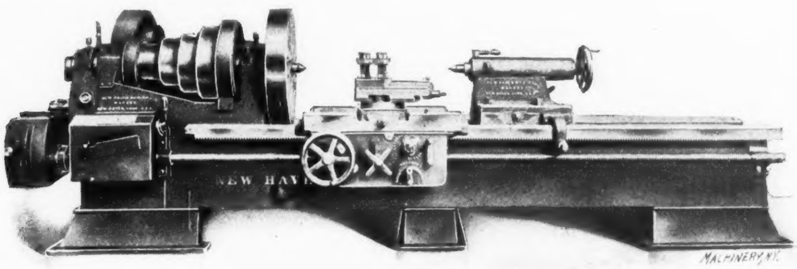


Fig 1. Heavy 28-inch New Haven Lathe.

The speed changing box at the front of the head-stock is of the design which we have described before (see the New Tools of the Month in the August, 1904, issue of MACHINERY), giving seven changes of speed. This number is quadrupled by the supplementary feed box at the end of the head-stock, whose mechanism is shown in Fig. 3, removed from the casing which encloses it when in place on the machine. Stud *A* carries the gear which receives the motion from the lathe spindle. About it is pivoted a rocking frame *B*, carrying pivots *C* and *C*, which each carry a pair of gears driven by the central pinion on *A*. Gear *D* is mounted on an extension of the shaft of the main feed box *E*. This gear may be made to engage with either one of the two gears on each of the two pivots *C* and *C* by the operation of handle *F*. Shifting *F* longitudinally brings gear *D* opposite the outer or inner gear

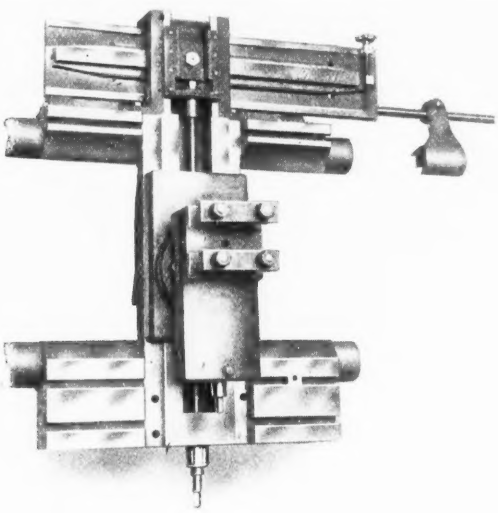


Fig. 2. Plan View of Taper Attachment.

on stud *C*. Shifting it vertically, by means of the connecting links *G*, rocks frame *B* to bring either the upper or lower gears on *C* into mesh with *D*. Four changes are thus provided for.

The design of the taper attachment is shown in Fig. 2. The taper bar is carried by a table, sliding in brackets attached to the back side of the carriage, and always in place. When it is desired to turn tapers, a clamp, which is fastened to the bed of the lathe, is tightened down on the rod which connects it with the table. The cross feed screw is connected by a tapered pin with the sleeve at the front of the slide which locates it so far as endwise movement is concerned. When this tapered pin is removed, and the clamp is tightened down on the rod, the attachment is ready for action. The tapered swivel bar is graduated at one end to read in degrees, and the other in inches per foot. A fine ajustment is provided for it by the screw and hand nut shown.

STURTEVANT HIGH-SPEED LARGE VOLUME FAN.

The original Sturtevant fan, invented over half a century ago by B. F. Sturtevant, was for high pressures and small

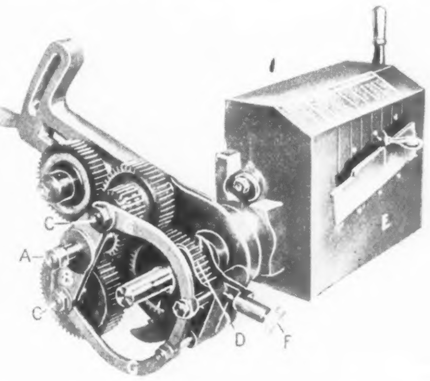
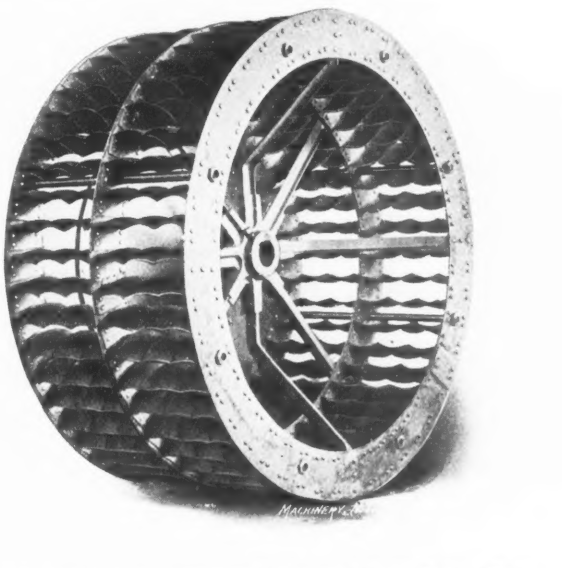


Fig. 3. Detail of Mechanism for Quadrupling the Number of Feeds obtained in the Feed Box.

volumes. It was intended particularly for exhausting the dust produced by the buffing wheel, in smoothing the soles of shoes. At that time it was thought necessary to use small pipes and maintain a high velocity throughout an exhausting system, and as the inventor naturally designed this fan for a pulley drive at the high rotative speeds existing in shoe factories, planing mills, etc., where the device was used, the



Design of Runner for Sturtevant High-speed, Large Volume Fan.

form of fan he developed had 24 or more blades, curved, and with a depth equal to about 1/8 the diameter of the wheel, which was very narrow. This was, and still is, the proper form for such service, where the volume required is small as compared with the velocity. Further study of the problem showed that there was a wide field for fans giving a large volume of air at low velocity. In many cases it is desirable to connect steam engines directly to the shaft, making the speed of the fan much lower than had previously been used. These and other considerations necessitated wider and fewer blades, giving the larger volume at lower velocity. At the same time the proportion of blade area to the volume was practically the same as in the type of wheel originally designed.

The B. F. Sturtevant Co., of Hyde Park, Mass., has recently added to these types a form intended for high speed and large volumes. Requirements of this kind have only been met with

in the past few years, with the growing use of the steam turbine and the electric motor. Still keeping the proportion of blade area to volume the same as in the previous types, the natural way to attain the desired result under the new conditions was to widen the wheel to give the increased volume, at the same time making the blades more numerous and considerably shallower, thus providing a large inlet area. In practice, slight changes in construction were found advisable to increase the efficiency and to reduce eddy currents and other obnoxious features. One of these improvements consists in making the floats for the high speed, large volume wheels with several cup-shaped cavities or spoons, as shown in the illustration. This prevents the air which enters the pockets from slipping along the length of the float, constraining it to enter and leave in a radial plane. The form of runner shown in the illustration is being regularly furnished by the makers for high speed, large volume service.

SIMONDS SCREW SLOTTING HACK-SAWS.

The Simonds File Co. of Fitchburg, Mass., is manufacturing extra thick, concaved hack-saw blades in sets of four, for the special purpose of slotting odd screw heads for tool and repair work. The general outline of one of these blades is shown in the accompanying line cut. The thickening of the width at the toothed edge gives the blade a clearance which allows it to be easily worked by hand, even on the widest size of the set, which is 0.109 inch thick. The other three saws are 0.083, 0.065 and 0.049 inch thick, respectively. These screw slotting blades, though they have been in the market but a short time, have already met with cordial appreciation on the part of tool makers, repair men and others, who have occasional jobs of screw slotting to do, which have hitherto been done in a patched up way with thin hack-saw blades, or on the milling machine with a milling cutter, at a considerable expense of time and labor.

Wide-face Hack-saw Blade.

HENDERSHOT SHAFT COUPLING.

This device, which is being placed on the market by Manning, Maxwell & Moore, Inc., 85-87-89 Liberty Street, New York, embodies novel features of construction which gives it great usefulness and effectiveness. The design can be easily understood from Figs. 1 and 2, of which the first shows it assembled, and the second separated into its component parts.

It is made in two complete halves, each half consisting of a body and a split tapered bushing, the latter bored to fit the shaft and turned to fit the tapered hole in the body of the coupling. The two bodies, which form the flanges of the coupling, are provided with interlocking lugs on their faces, which take the torsional strain of the transmission, the bolts being required only for compressing the sleeve on the shaft. A turned ledge on the face of one flange fits a turned recess on the face of the other, thus serving to keep the shafts concentric with each other and in correct alignment.

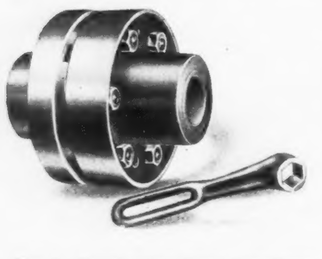


Fig. 1. Hendershot Shaft Coupling, Assembled.

Among the advantages of this construction are the following: The two parts of the coupling may each be assembled on its own shaft while they are on the floor, before being hoisted into place, thus facilitating the work of erection. Owing to the fact that two taper bushings are used instead of one, differences in diameter of the two shafts are taken care of without the slightest difficulty. The transmission of the turning moment by interlocking lugs instead of by the bolts, relieves them of a large share of the strain; though, in accordance with the plan of making this coupling unusually strong, even greater bolt area than usual is provided. The tapered bushings are made quite thin, while the hubs are proportionally large, thus obtaining great strength and holding power with the application of comparatively little force in clamping.

It will be seen that this device is, in use, simply two positive interlocking couplings of the old style, presenting, with the improved design, the advantages of not requiring to be accurately fitted to the shafts, driven on them, or have key-

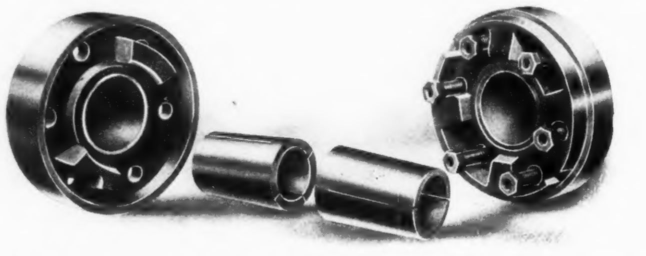
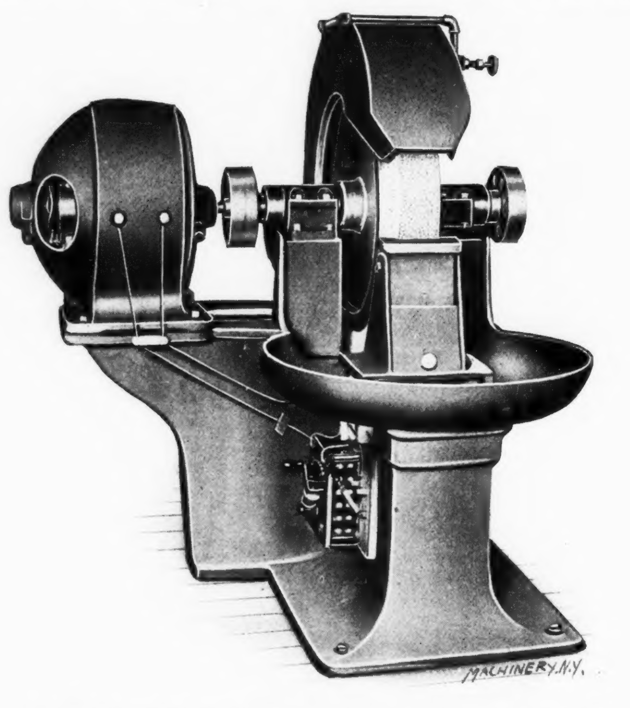


Fig. 2. The Construction of the Coupling, as shown by the Component Parts.

ways cut in the latter. The coupling is easily taken apart by screwing two bolts into holes tapped in the shell for that purpose. Each complete set is put together on a test bar and inspected before it leaves the factory.

BRIDGEPORT DROP APRON TOOL GRINDER.

The principal peculiarity of the tool grinder shown in the engraving is the fact that the rim of the bowl which surrounds the wheel stand has been made considerably lower than is usually the case. The reason for this construction is to be found in the necessity for grinding tools much larger and



Tool Grinder with Low Bowl or Apron, for Grinding Long-shanked Lathe or Planer Tools.

longer than was the case when the original designs of wet tool grinders were first brought out. The great size and length of these tools makes it almost impossible to grind them at the proper angles on grinding machines as ordinarily made with the high bowl or apron, it being impossible to lower the shank to an angle sufficient to give the proper bevel.

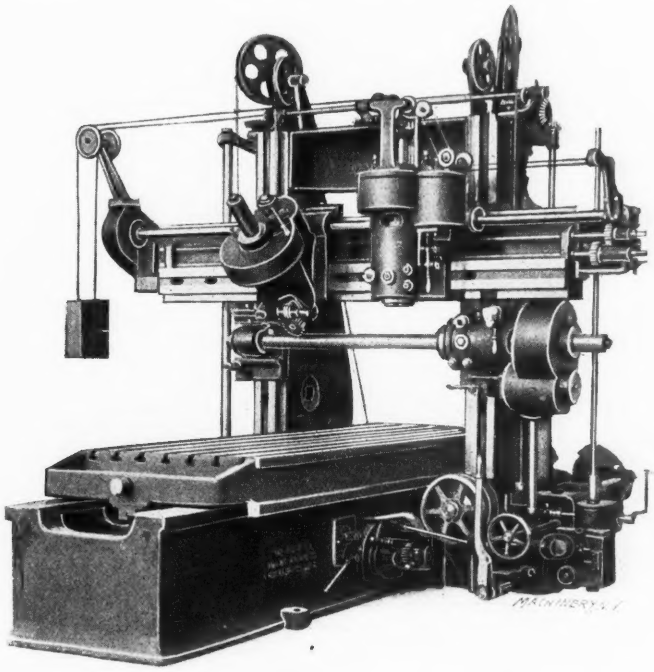
In its general construction, the tool is similar to other machines the builders brought out. The base forms a large water tank supplying the centrifugal pump, which forces a full stream of water to the wheel. The tool may be either belt or motor driven. When belt driven, it is equipped with tight and loose pulleys on the emery wheel spindle, with a self-locking belt shifter to hold the belt on the desired pulley. This shifter is within easy reach of the operator. When driven by a direct-current motor the motor is mounted on a substantial bracket, cast integrally with the base, as shown in the engraving. The armature spindle is then directly coupled to the wheel spindle. When arranged for an alternating-current motor, the motor is back geared to the wheel spindle, being mounted on a bracket similar to the one shown.

The device is made for a 36-inch wheel, with a 4-inch face, 20 by 2½ inches. The emery wheel should run about 425 or

450 revolutions per minute. The weight of the machine with motor is 2,600 pounds. It is built by the Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn.

INGERSOLL MILLING MACHINE WITH HORIZONTAL, VERTICAL, AND ANGULAR SPINDLES.

The milling machine shown in the accompanying half-tone was designed by its builders, the Ingersoll Milling Machine Co., Rockford, Ill., for milling the general run of work requiring the finishing of plane surfaces on the top, sides and ends. The angular spindle, shown in the cross rail, is a special provision for finishing the surfaces of inclined pillow blocks for gas engine frames.



An Ingersoll Miller with a Special Head for Facing Gas Engine Pillow Blocks.

Each of the two heads on the cross rail has an automatic reversible feed across the machine in either direction, each taking in the full width between the housings. The angular head may be readily removed, if it is not required for a considerable period of time, though it is not in the way of ordinary work when moved to the extreme end of the cross rail. When using the vertical heads, the horizontal arbor shown in place on the machine is removed. It can be seen that in finishing horizontal surfaces, either slabbing cuts or end mill cuts can be used.

It will be noticed that the horizontal head is at the operator's side of the machine instead of being mounted on the further cross-rail, as is common in machines of this kind. This makes it much more convenient for the operator in setting to proper depth of cut when using face mills. The horizontal spindle head, the cross-rail, and the spindle of the vertical head, are all counterbalanced to make the adjusting of the machine as easy as possible. The spindles are driven by spur gears cut from solid forgings, and are encased so that they can be packed in grease.

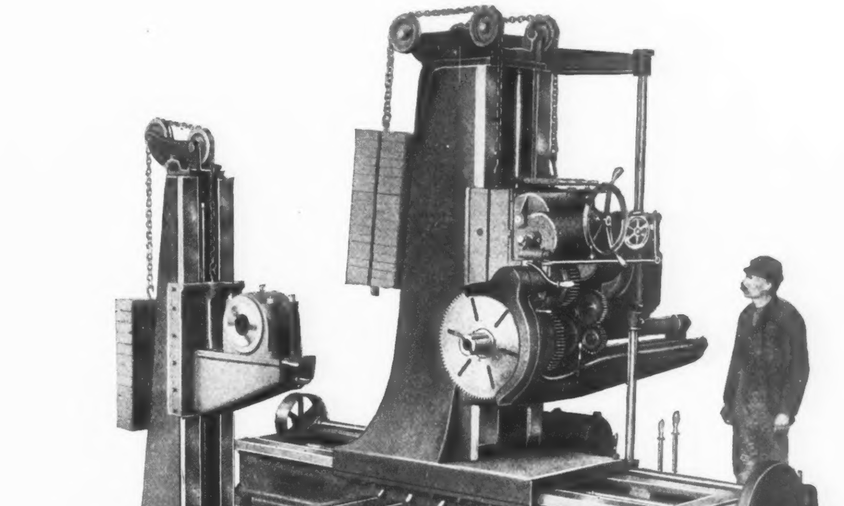
This machine is made in two standard sizes, 36 inches and 46 inches width, with any desired length of table. The positive table feed has eight changes for each cutter speed, giving a range of from ½ inch per minute up to 15 inches per minute. The quick power adjustment in either direction is about 30 feet per minute. The axial adjustment of the vertical spindle is 8 inches, that of the horizontal spindle being the same.

HAMILTON NO. 3 HORIZONTAL DRILLING, BORING, AND MILLING MACHINE.

The tool shown in the engraving is built by the Hamilton Machine Tool Co., Hamilton, Ohio. It is a drilling, boring and milling machine of heavy and rigid construction, characterized by a facility of adjustment and operation unusual in a machine of this size. It is particularly adapted to the handling of unwieldy pieces which are difficult or inconvenient to move. After these are once placed on the floor-plate, the spindle can be adjusted horizontally and vertically to perform different operations within its range, resulting in a saving of time and the obtaining of greater accuracy than by less improved methods of doing the work. The operations of drilling, boring and tapping, together with milling of slides, bearing surfaces and T-slots, can all be performed at one setting of the work.

In its general construction, the machine consists essentially of a floor-plate to which the work is fastened, combined withh a transverse bed along which a column may be adjusted or fed to any desired position within its range. The column carries the boring spindle in a slide on its face. An outboard support for the boring bar is also furnished, which is clamped in a suitable location on the floor-plate.

Power feeds and quick traverse movements in both directions are provided for the column on the bed, for the slide up and down the face of the column, and for the spindle in and out of its bearings in the slide. Graduations are provided for reading the various adjustments used for column slide and spindle, as well as for the adjustments of the outboard bearing, so that the matter of setting the machine for a given operation is a simple one. The spindle slide on the column is counterweighted, as also is the supplementary slide on the outboard bearing.



A Drilling, Boring, and Milling Machine of Rigid and Convenient Design.

The various spindle speeds and feeds are obtained from a single pulley running at constant speed, the changes being made by positive quick change mechanisms controlled by suitably placed levers. All the changes can be made while

the machine is in motion. There are eight changes for the feed of the column, slide and spindle, ranging between 0.0196 and 0.66 inch per revolution of the spindle for the column and slide, and from 0.001 to 0.033 inch per revolution for the longitudinal feed of the spindle. Positive quick change gearing with suitable levers provide for 16 spindle speeds in geometrical progression, ranging from 2 to 180 revolutions per minute. The mechanism for these changes is suitably enclosed and guarded, and the controlling handles are located within easy reach of the operator, as are those for the quick power movements. The single pulley drive makes the use of the motor drive a simple matter, it being merely necessary to replace the driving pulley with a constant speed motor.

The floor-plate, shown in the engraving, is 8 feet long by 6 feet wide and 10 inches thick. The area of this plate may be altered to suit the requirements of the purchaser. The traverse of the column on the bed is 72 inches; of the spindle slide on the column, 40 inches; and the longitudinal traverse of the spindle is 36 inches. The distance from the center of the spindle to the top of the floor-plate may be adjusted within the limits of 24 inches and 64 inches. The machine, as shown, weighs about 30,000 pounds.

HILBERT UNIVERSAL DRILLING TABLE.

The accompanying half-tone shows a device made by the Hilbert Machine Co., Cincinnati, Ohio, for increasing the range of usefulness of the ordinary drill press or radial drill. It is a universal attachment, permitting holes to be drilled at any angle in either of two planes, giving access to all sides of the work except the face upon which it is clamped.

The attachment consists of a circular table, pivoted at the center and capable of being swung to any angle about the axis perpendicular to its face, with provision for clamping to any desired position when it is obtained. The holder to

A Device for Presenting Work to the Drill Press at any Desired Angle.

which the table is pivoted is mounted on trunnions, carried by standards integral with the base, so that the work fastened to the table may also be adjusted about a horizontal axis. A worm-wheel sector with adjusting worm is provided for this motion, making it easy to handle heavy work with delicacy and certainty. When desired, for rapid adjustment the worm may be dropped out of mesh with the sector, and the table swung over by hand. Clamping mechanism is provided for this adjustment also. When used in connection with an ordinary drill press it will be seen that this device will perform many of the functions of the universal drill.

The base of the table is 14 x 14 inches, and the height from the horizontal clamping surface to the base is 22 inches. The table is 25 inch in diameter.

LANDIS STAY-BOLT CUTTER.

The Landis Machine Co., of Waynesboro, Pa., is building the stay-bolt cutter, illustrated in Fig. 1. The principal feature of this machine is the avoidance of the lead-screw, which has hitherto been considered necessary in stay-bolt threading machines to bring the thread of the stay-bolt to exactly the right pitch, so that it will match up with the holes in he boiler plates as tapped by the stay-bolt tap. If the pitch of the stay-bolt is not exactly proper, contiguous bolts in the boiler being of different pitches, the continuous threads produced by the tap will force the plates apart at different distances, thus straining both the plates and the bolts.

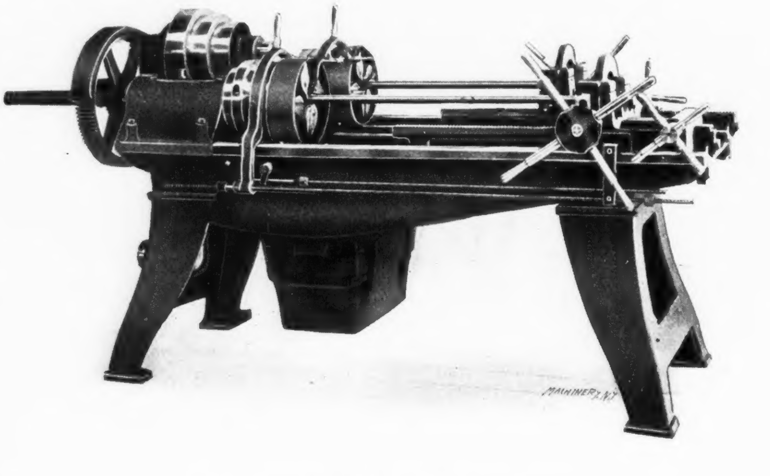


Fig. 1. Double Head Landis Stay-bolt Cutter.

The builders have adopted their regular form of chaser for this purpose, obtaining with its use, a high degree of accuracy without requiring the incorporation of a lead-screw in the machine. One of the chasers is shown in Fig. 2. As may be seen, the teeth are not hobbed, but milled. They are set in the head, tangent to the work, with the front ground at an angle so that the work only bears on the cutting edges for the first few teeth. The finished threads bear on the back of the cutting edge on the milled surface of the threads of the chaser. The work and the chaser together, thus furnish the lead-screw and nut for the machine. These chasers are carefully made, and very accurate results are secured. When a lead-screw and die are used, if they are not exactly the same pitch, the two work against each other, producing rough and torn threads.

Another advantage of the type of chasers shown is the fact that they are ground on the end only, and so may be sharpened repeatedly until the full length is used up. The end may also be ground at any angle to suit the material being worked on, it being possible to produce a curling chip, as with a lathe tool. The die never requires to be annealed, hobbed or retempered, consequently it is not subject to the changes which occur in rehobbing dies, and has a life far in excess of the old style type. The head in which it is mounted is arranged to swing the cutters apart or bring them together, so as to cover a wide range of diameters.

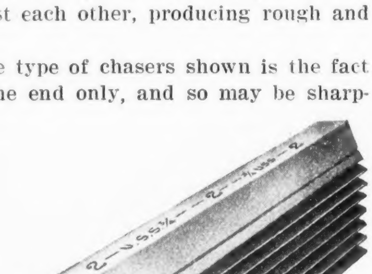


Fig. 2. Type of Chaser used in Landis Bolt Cutter.

The carriage of this machine has an adjustment vertically and sideways. The cutting strain is exactly central. The rack is provided with recesses between the teeth, so that it is impossible to clog them up with chips or scale, which are allowed to fall through into the base without interfering. The machine is built in single and double head arrangement in sizes up to 1½ inch diameter.

BRITISH INDUSTRIAL NOTES.

The previously mentioned downward tendency in British industrial returns continues, though not apparently at such a rate as to justify unduly pessimistic views. Here and there, slackness is pronounced; for instance, in Sunderland considerable distress prevails, as a consequence of the abnormal scarcity of ship-building orders, due to a number of causes, one being the high prices of ship-building material, another the high price of coal acting unfavorably on the shipping trade. In the Midlands, Wolverhampton has experienced several set-backs within recent years, due to the removal of large works to more favorable positions near the seaboard, the railway companies appearing unable, or unwilling, to assist—by reduced rates of carriage—in the retention of these businesses. Two works engaged in the manufacture of puddled iron, have just been sold, ostensibly on account of inability to meet competition, though an impression prevails in some quarters, that it is more in consequence of the pooling of financial interests. At the same time it is reported that the size of the large works formerly occupied by Daniel Lysaght & Co., who removed to Newport, South Wales, has been purchased by a London syndicate which will probably build new works, and Sir Alfred Hickman will entirely reorganize and equip the large steel smelting and rolling mill plant at the neighboring town of Bilston, electrical driving being adopted on a considerable scale.

Banks and Banking.

Though the subject of banking methods is not too often included in reports on engineering industry, the present financial troubles in the United States—sympathetically felt in other countries—may justify reference to an important paper on "A Decade of Bank Amalgamation," prominent points raised including the fact that since 1897 no fewer than eighty-five British banks have ceased to exist through amalgamations, a chief feature being the continued disappearance of the once powerful private banker. Tables given in relation to British joint stock banks, their assets and liabilities, show their great solidity. For every £100 of deposit liability the banks hold £30 in liquid assets, £17 in A1 investments, £62 is employed in making advances and discounting bills for the trading community, leaving only £9 in bank premises and cover for acceptances. In addition there is the guarantee of the uncalled capital which is equal to £24, or a total security of £142 for every £100 of deposit liability.

Franco-British Exhibition in 1908.

Considerable interest is being evinced in the Franco-British Exhibition to be held at Shepherd's Bush, London, in 1908. There appears some probability of a representative show of British and French machines and products. The buildings, etc., will cover forty acres.

Ship-building.

In ship-building, recent developments include the complete removal of Messrs. Yarrow from the Thames to the Clyde, which will take place immediately the last torpedo boat, now under construction, is completed. Operations, more particularly boiler-making, are now in progress at the new works. Messrs. Thorneycroft have practically removed all their naval works from Chiswick to Southampton, their latest production, which has just gone through its trials, being the turbine-driven destroyer *Tartar*, which in three runs, with and against the tide, attained the record speed of 35.95 knots. The *Ghurka*, another ocean-going turbine destroyer, built by Hawthorn, Leslie & Co., in her official six hours' trial attained an average speed of 33.91 knots. She proved her ability to steam a distance of 1,715 knots at a speed of 13½ knots without replenishing her fuel supply, which is considerably better than the Admiralty requirements. If supplementary oil tanks were fitted, she could steam 2,500 knots without taking on board more fuel.

Interesting Foundry Practice Development.

In foundry practice, a method, developed by Dr. Szekely, Sr., of 113 Clements Inn, London, of producing iron castings in metal molds shows interesting and suggestive results, there being practically no shrinkage. The molds are treated by a wash, and all castings produced are soft. We understand that Alfred Herbert, Ltd., Coventry, produces a number of its castings on these, or somewhat similar lines. Speaking broadly, more consistent attention than formerly is being devoted to the layout, equipment, and management of foundries, the British Foundrymen's Association being an active agent in the dissemination of information and suggestions calculated to improve the general status of the foundry, which, though essential to engineering, has never been as well recognized as its importance would naturally suggest.

Lifting and Conveying Machinery—Sugar Machinery.

The manufacture of cranes and lifting and conveying appliances in general, has made substantial though unobtrusive progress of late years in this country. One of the most prominent concerns in Great Britain is that of Appleby's, Ltd., of Leicester and London, which by amalgamation with a Glasgow firm, and, more recently, with the Temperley Transporter Co., is now particularly well equipped for dealing with practically all branches of this important section. The building of the heavier traveling cranes, especially since the general adoption of electric driving, has often been dealt with by machine tool makers in conjunction with their regular output, but where such is still the case, the work is to all intents and purposes produced in a distinct shop or department. Iron and steel foundries, as well as ship-building yards, have contributed largely to the increased demand for powerful lifting appliances, while the general run of industries are increasingly alert as to the advantages obtainable from rapid internal transit of material. All the same, the number of plants concerned in this branch of work seems, to say the least, fully adequate to the demands made on their output.

In addition to other considerable orders, The Mirrlees-Watson Co. of Glasgow, has recently had placed in its hands the contract for the whole of the buildings and plant for a large sugar refining works in the State of Morelos, Mexico, the layout being such as will admit of easy extension. In the Glasgow district generally, things in the engineering and tool-making line are decidedly less brisk than for some time past.

Milling Machine Development—Yorkshire Tools.

In the way of milling machines, considerable advances have, within the last few years, been made by British manufacturers both as regards power provided—with proportionate stability—and ease of manipulation. This has taken place in all the branches of this class of tool from the heaviest and more simple forms, to those in which comprehensiveness of function for small and medium work is the leading characteristic. About eleven years ago (March, 1897) the writer contributed a short article to this journal, on Yorkshire tools, dealing with the phenomena of the extremely low priced tools which then formed the staple product of a number of makers in several districts. A number of Yorkshire friends obtained the impression that undue severity towards Yorkshire practice was evinced in the paper, though nothing was mentioned that could not easily be upheld, and full allowance was made for ruling conditions, and due credit given for wonderful value for price paid. However, the change in absolute value and accuracy of machine tools easily obtainable in Yorkshire during the last seven years or so, cannot be over emphasized. The amount spent in the most approved plant, organization, and design, must be enormous, and the result has more than justified the expenditure. Since the Paris Exposition of 1900, one firm alone—Dean, Smith & Grace, Ltd., Keighley, has at least trebled its turnover, having, since then, specialized on one form of machine tool only—lathes. On Japanese account alone, they have supplied over 250 lathes. The only tools built outside of lathes are special machines for their own use which cannot conveniently be obtained from other makers. The great majority of the lathes turned out are cone-driven and specially adapted for high-speed work, though all-gear-head machines are built to special order or to meet certain conditions. A line now being produced very successfully is that of four-jaw independent chucks, it very early being seen that the then commercially obtainable chucks were far from equal to the duty imposed by high-speed steel. JAMES VOSE.

Manchester, Eng., December 31, 1907.

OPENING OF THE NEW ENGINEERS' CLUB BUILDING.

On the evening of January 11, more than 600 men of prominence in the engineering, architectural, and industrial world, met at the new Engineers' Club house in Philadelphia for a house-warming and reception. It probably was the largest and most representative gathering of engineers ever held in Philadelphia. The event marked the thirtieth anniversary of the club, which has had a long and creditable career.

The new club house, which is situated at No. 1317 Spruce Street, was formerly the residence of Mr. Charles Potts, a wealthy iron manufacturer. It was designed by Mr. Lewis Hickman on such broad lines that when the Engineers' Club purchased it, it was found to need little alteration to convert it into an ideal club house. The purchase price was $55,000, and $15,000 additional was spent in changes and furnishings.

Fig. 1. New Engineers' Club of Philadelphia.

The building, which is of brownstone and four stories in height, has a frontage of 25 feet and a depth of 140 feet. At the right of a wide hall is a lounging and reception room 17x48 feet, fitted with two costly mantel pieces, one of solid onyx and the other of mahogany. In this room is a chandelier valued at several thousand dollars, which was imported by Mr. Potts from Turkey. Handsome mahogany tables and leather upholstered chairs make this room most comfortable and inviting.

The meeting hall is on the second floor in the front. This was two rooms which are now converted into one large room 24x48 feet. Here can be seated 200 persons, and it is the intention of the club to hold not only semi-monthly meetings of the club here, but also all business meetings. In the rear of the meeting room is a closet wherein can be installed the stereopticon apparatus when it is not in use. The room is lighted by electric lights hung close to the ceiling in front of the ceiling beams so that the rays of light do not dazzle the eyes of those seated in the auditorium.

The library, a room 17x34 feet, filled with books and periodicals, is on the second floor, at the rear of the meeting hall. The floor of this room is covered with cork carpet. Back of the library is a small room used temporarily by the officers, but which will eventually be used as a conversational corner. On the third floor are six comfortably furnished bedrooms for convenience of out-of-town members. On the fourth floor a room 17x67 feet is given over to a playroom, being equipped with pool tables, shuffle board, etc. There are also two bedrooms, a bath and committee room on this floor.

The Engineers' Club was founded December 17, 1877, at a gathering of twenty-one engineers at the home of Dr. Coleman Sellers.

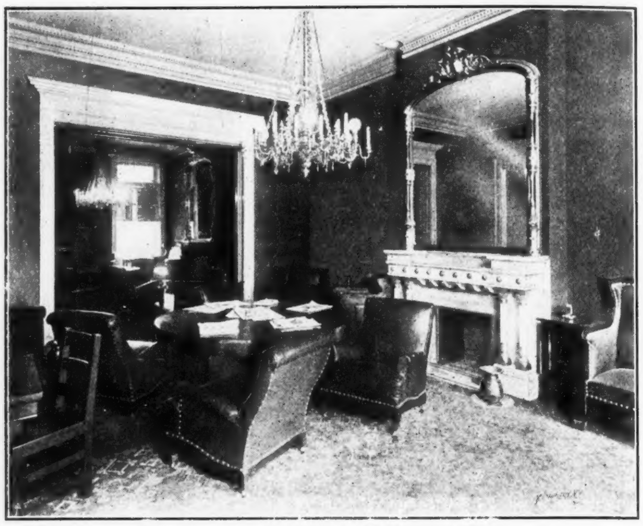


Fig. 2 Lounging Rooms, Engineers' Club

Fifty members were quickly enrolled, and the growth of the club has been going on steadily since. Some very notable papers have been contributed by its members. Of the original members who organized the club, there are only three surviving, these being Mr. Wilfred Lewis, Mr. Chas. A. Billin, and Mr. M. R. Muckle, Jr. The present membership is about 590. The recent growth has been rapid, about 124 new members having been enrolled within the past few months.

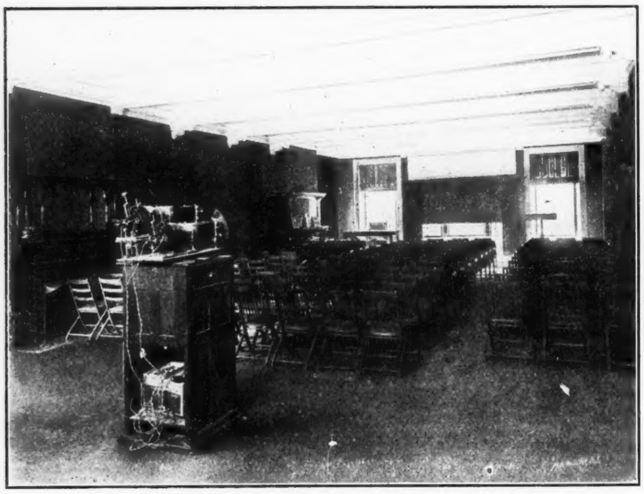


Fig. 3. Meeting Hall, Second Floor, Engineers' Club.

The following are the officers: President, H. W. Spangler; vice-presidents, Washington Devereux, W. P. Dallett, Wm. Easby; secretary, Francis Head; treasurer, George T. Gwilliam.

* * *

THE MACHINERY CLUB, NEW YORK.

Plans for the new Machinery Club are practically mature at the present writing, and all the contracts for furnishing, equipment and decoration have been made. The Fulton Building, whose two upper floors, the twenty-first and twenty-second, the club is to occupy, is to be ready April 15, while the contracts are all called for completion on April 1, so there should be no delay in geting into the quarters as soon as the building is completed.

The architect's plans show a very elaborate and serviceable lay-out. The twenty-first floor will be occupied by the offices, hall, coat room, reception room, etc., and the main dining-room. This latter will be of sufficient size to accommodate 500 guests during the luncheon period, between 12:30 and 2 or 3 in the afternoon. In addition to this, there is, on this floor, a large grill-room and a bar. The top floor of the build-

ing, the twenty-second, is provided with a ladies' dining-room, a smoking-room and a number of private dining-rooms. Only a part of this story is housed in, the remainder being fitted up as a roof garden, to be used in pleasant weather. This should be an especially attractive feature, as the building is a lofty one near the water's edge, on the outskirts of the high building district, with unobstructed view in almost every direction. The kitchens are also on this floor, in the rear of the building.

As we have previously explained, the membership of this club is divided into three classes; resident members, suburban members and non-resident members. We are informed that over 500 membership applications have been accepted by the committee on membership, these being about equally divided between resident and non-resident members.

* * *

PERSONAL.

Walter B. Snow, publicity engineer, Boston, Mass., has been elected president of the alumni association of the Massachusetts Institute of Technology.

A. L. Roberts has entered the employ of Pawling & Harnischfeger, Milwaukee, as mechanical and designing engineer. Mr. Roberts was for eighteen years with the Morgan Engineering Company.

T. D. W. Moore, general manager of the Remington Arms Co., Ilion, N. Y., has resigned his position, and will be succeeded by Mr. Jerome Orcott, general manager of the Union Metallic Cartridge Co., Bridgeport, Conn., as general manager and superintendent.

Gorham C. Parker, formerly head of the selling department, Jacobs Mfg. Co., Hartford, Conn., has been made sales manager of the Wm. J. Smith Co., New Haven, Conn., manufacturer of adjustable reamers, automatic tools and special machinery.

George A. Gauthier, formerly chief draftsman and designer of the Universal Screw Machine Co., Hartford, Conn., has taken a position in Toronto, Canada, to design machinery for the Caldwell double-thread wood screw, which is being developed by Worth & Martin of that city.

D. G. Baker, who has been superintendent of the Remington Arms Co., Ilion, N. Y., for the last three years, has resigned that position, and will become one of the engineering firm of S. M. Green, Inc., Holyoke, Mass. Mr. Baker will remain in Ilion with the Remington Arms Co. as consulting engineer for some time.

H. F. Sanville, who has been for the past two years with Dodge & Day, engineers, of Philadelphia, joined the organization of Frank B. Gilbreth, general contractor, on the first of the year. Since completing his engineering education at Columbia University, in 1892, Mr. Sanville has had a very wide experience in engineering and construction, as well as in commercial lines. For the past four years he has been secretary of the Philadelphia section of the American Institute of Electrical Engineers.

A dinner was given by the American Museum of Safety Devices and Social Hygiene at the rooms of the Aldine Association, January 15, in honor of the decorations conferred by the French Republic upon Mr. Charles Kirchhoff, editor the *Iron Age*, Mr. T. Commerford Martin, editor *Electrical World*, and Rev. Percy Stickney Grant, rector Church of the Ascension. Mr. Elbert H. Gary, chairman of the U. S. Steel Corporation presided, and John La Farge, the eminent painter, conferred the decorations of Officier de L'Instruction Publique.

* * *

MEMORIAL SERVICE FOR LORD KELVIN.

An impressive memorial service in honor of Lord Kelvin, who died December 23, was held in the Engineering Societies Building, New York, Sunday, January 12, under the auspices of the American Institute of Electrical Engineers, assisted by representatives of the American Society of Mechanical Engineers, American Society of Civil Engineers, and other leading engineering societies of United States and Great Britain. The program included the reading of memorial resolutions by the secretary. These were adopted by a rising vote. President Stott of the American Institute of Electrical Engineers made appropriate introductory remarks, and introduced Prof. Elihu Thompson, whose subject was: "Lord Kelvin as an Electrical Engineer." He was followed by Prof. E. L. Nichols with the subject, "Lord Kelvin as a Scientist." Mr. G. G. Ward, vice-president of the Commercial Cables Co., spoke on the subject, "Lord Kelvin's Work in Submarine Telegraphy," and Rear Admiral Geo. W. Melville, U. S. N., treated of his work in naval engineering. To T. C. Martin was given the subject of Lord Kelvin's relation to the American Institute of Electrical Engineers. Mr. Ward's remarks were of much interest because of his intimate connection with submarine telegraphy, in which Lord Kelvin's most notable commercial success and widest fame were won. The mirror galvanometer, which was followed by his equally sensitive and more practical siphon recorder, are rated among the most remarkable instruments ever devised. The effects of inductance, reactance and capacity in very long submarine cables prohibits the use of strong electrical currents. The first cable laid in 1858 was ruined by disregard of Lord Kelvin's advice, the insulation being broken down by using too great battery power. The mirror galvanometer responds to impulses so feeble as to be almost inconceivable. It is asserted that a battery contained in the bowl of an ordinary clay pipe is sufficient to operate an ordinary ocean cable of 2,000 or 3,000 miles length.

* * *

OBITUARY.

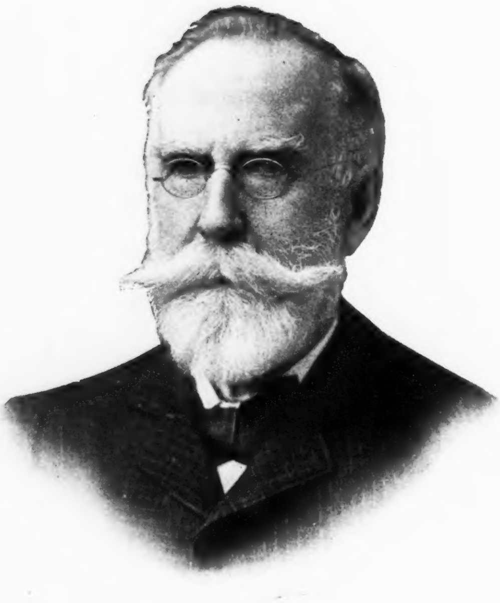
George V. Cresson, president of the George V. Cresson Co., Philadelphia, Pa., died at his country home near Philadelphia, January 18, at the age of 71.

Charles W. Martin, Jr., assistant general manager of Jenkins Bros., New York, died at his home in Bay Ridge, South Brooklyn, December 31, of pneumonia, following an attack of the grippe. Although Mr. Martin was only thirty-seven, he had been in the employ of Jenkins Bros. twenty-one years, having entered their employ when a boy of sixteen. He was one of the best known men in the power plant and railway supply fields and had a wide circle of friends. He leaves a wife and two children.

Matthias N. Forney, a well-known retired engineer, author, editor and publisher, died of paralysis January 14. He was born March 28, 1835, in Hanover, Pa. Mr. Forney displayed a marked taste for mechanics at an early age, and in 1852 entered the shop of Ross Winans as an apprentice to learn the building of locomotives. Following his apprenticeship in the shop and drafting-room was a period of varied mechanical and mercantile experience during which he was granted a patent in 1866 for the celebrated "Forney" tank locomotive, which was used for years on the elevated railways of New York City, and in large numbers by contractors, etc. In 1870 he became associate editor of the *Railroad Gazette*, and in 1873 brought out his celebrated Catechism of the Locomotive, which has had a large sale. He was later the editor and part owner of that Journal, severing his connection in 1883. In 1886 he bought the *American Railroad Journal* and Van Nostrand's *Engineering Magazine*, which were consolidated under the name *The Railroad and Engineering Journal*, later being changed to *American Engineer and Railroad Journal*, under which name it is still published. Mr. Forney was very active in the Master Mechanics' and Master Car Builders' Associations. He was married for the first time about one year ago.

DR. COLEMAN SELLERS.

The death of Dr. Coleman Sellers, at his home in Philadelphia, Pa., December 28, removed one whose ingenuity and taste did more, perhaps, than any of his contemporaries to make American machine tools the standard of excellence and efficiency the world over. He was born in Philadelphia, January 28, 1827. His early education included a course in the academy of Anthony Bolman, West Chester, Pa., from which he graduated at sixteen. To possibly benefit his health, which was not robust, he was advised to engage in agricultural pursuits for a year or so after graduation, but his tastes were too scientific and mechanical to long permit him to follow this prosaic occupation, but during this period his inventive



Dr. Coleman Sellers.

genius was displayed in the invention of a metal tooth hay-rake on wheels that anticipated by many years the modern implement.

At nineteen his brothers in Cincinnati gave him a position as draftsman in the Globe Rolling Mills in that city, and before he was twenty-one he was made superintendent and general manager of the mills. This fact of having gained a thorough insight into the manufacture of iron in less than two years, coupled with evident executive ability, early developed, speaks eloquently for his extraordinary talents. In 1851 at the age of twenty-four he was made foreman of Niles & Co., locomotive builders of Cincinnati, the founders of the present Niles Tool Works branch of the Niles-Bement Pond Co., at Hamilton, Ohio. Five years later he returned to his home city, Philadelphia, and became chief engineer of Wm. Sellers & Co., and later was made a member of the firm.

His inventive genius and skill as a designer soon put the Sellers machine tools, already well-known, in advance of competitors. Those were the days of piano legs, beading, fluting, scroll work and other *outré* architectural ornaments in machine design, now regarded as ridiculous, but then considered to be quite the proper thing. Young Sellers discarded the clumsy and inappropriate designs, and made shapely and well-proportioned forms which coupled with superior mechanical design throughout, easily made Sellers tools the best produced. He was the first to devise the scheme of rational design in proportioning shafting, hangers and pulleys for power transmission, thus revolutionizing the power transmission business which had grown up under the totally unsound and ungainly system of selling by the pound. The obvious effect of this practice, of course, was to make the power transmission parts as heavy as possible without particular regard to the stresses transmitted. In these days of copious half-tone illustration, it is interesting to know that Mr. Sellers was an "amateur" photographer who materially advanced the art by his experiments and practice. He took it up in 1858, having recognized its value for advertising machine tools.

Dr. Sellers was associated with Wm. Sellers & Co. for thirty years, resigning in 1886 to enter consulting engineering practice. In 1889 he was retained to assist in the power development of Niagara. It is of melancholy interest that Dr. Sellers and Lord Kelvin, both having been connected with the pioneer development of this great water-power, died only five days apart. Lord Kelvin, then Sir William Thompson, was chairman of the International Commission of five members appointed to develop the plan of power development, and Dr. Sellers was consulting engineer. He acted both as consulting engineer of the Cataract Construction Co. and as chief engineer and president of the Niagara Falls Power Co.; also as chief mechanical engineer of the Canadian Niagara Power Co. His work in the pioneer development of these great water powers would alone establish his standing as a great mechanical engineer of international renown. Besides the mechanical features of the dynamos, improvements in the shaft bearings and other details of the installation, his advice guided the company safely through the whole of the initial development, both as to the mechanical as well as the electrical features involved.

Dr. Sellers was a member of the leading engineering societies of the United States and Great Britain; he was a charter member of the American Society of Mechanical Engineers. At the time of his death he was associated in consulting work with S. Howard Rippey and H. W. Sellers, of Philadelphia, under the firm name of Sellers & Rippey, the practice being now continued by the junior partners.

* * *

NEW BOOKS AND PAMPHLETS.

PROCEEDINGS OF THE TRAVELING ENGINEERS' ASSOCIATION; FIFTEENTH ANNUAL MEETING, CHICAGO, ILL., September 3-6, 1907. 340 pages, 6 x 9 inches. W. O. Thompson, secretary, Buffalo, N. Y.

PROCEEDINGS of the Twenty-seventh Annual Convention of the American Water Works Association, held at Toronto, Ontario, Canada, June 17-21, 1907. 527 pages, 6 x 9 inches. Published by the Secretary, J. M. Diven, 14 George St., Charleston, S. C.

COAL MINE ACCIDENTS, THEIR CAUSES AND PREVENTION. By Clarence Hall and Walter O. Snelling, with introduction by James A. Holmes. 22 pages, 6 x 9 inches. Published by the Department of the Interior, U. S. Geological Survey, Washington, D. C.

REPORT of the Proceedings of the Fifteenth Annual Convention of the International Railroad Master Blacksmiths' Association for 1907. 244 pages, 5¾ x 8¼ inches. Published by the association. A. L. Woodworth, Lima, Ohio, secretary.

AMERICAN SOCIETY OF TESTING MATERIALS; PROCEEDINGS OF THE 10TH ANNUAL MEETING, held at Atlantic City, N. J., June 20-22, 1907. 759 pages, 6 x 9 inches. Published by the society, Edgar Marburg, secretary-treasurer, University of Pennsylvania, Philadelphia, Pa.

Technical Literature, published by the Technical Literature Co., 220 Broadway, New York, has been changed in name to the *Engineering Digest*. This publication, as many of our readers doubtless know, is a review of the general engineering press, and is intended to give its busy readers a comprehensive idea of the best and most important current articles without the drudgery and time-consuming process of reading all the technical and trade publications.

BANKER'S MATURITY GUIDE AND HOLIDAY CALENDAR. 32 pages 5x6¾ inches, with thumb index. Compiled and published by Sperry & Morgan, Hartford, Conn. Price, 50 cents.

This convenient little work is a summary of the laws and customs in the United States and possessions, Canada, Cuba, and Mexico, governing days of grace, Saturday half-holidays, maturities of negotiable paper, legal rates of interest, etc. It should be of value to manufacturers and others generally doing business in the various states and countries represented.

THE STUB TOOTH GEAR. 24 pages, 6 x 9 inches, illustrated. Published by the Fellows Gear Shaper Co., Springfield, Vt., for free distribution to those interested.

This pamphlet describes in a very convincing fashion the merits of the involute gear tooth of shortened addendum and increased pressure angle, as exemplified in the "stub tooth" system introduced by the Fellows Gear Shaper Co. The subject is discussed very plainly, with a profusion of explanatory diagrams. It is stated that fully one-third of the cutters ordered from this firm, are now required by customers to be of the stub tooth form.

MACHINE DESIGN. By Charles L. Griffin. 186 pages, 6 x 9 inches. 82 line illustrations. Published by the American School of Correspondence, Chicago, Ill. Price $1.50.

This work is substantially the same as the well-known work on machine design published by Mr. Griffin some years ago. It is bound in red cloth binding, uniform with the edition of books on various mechanical and electrical subjects now being issued by the American School of Correspondence. As a simple and comprehensive work on machine design on the subjects treated it is one of the most clear and logical that we have ever examined. It is deservedly popular.

WM. DAWSON & SONS, LTD., Cannon House, Bream's Buildings, London, E. C., England, have sent us their little "red book" listing annual subscriptions to English and foreign magazines, newspapers, etc. This list of the principal daily, weekly, and monthly papers and magazines is arranged alphabetically, with subscription prices for a year, both for England and abroad. A classification follows enabling one to find at a glance all papers on a certain subject or science. The little book also includes a full list of the principal American, Canadian, Australian, Chinese, Japanese, French, German, Indian, etc., newspapers, there being in all 5,000 listed. Copies are sent to any address on application.

SPECIFICATIONS AND CONTRACTS. By J. A. S. Waddell, with Note on the Law of Contracts by John C. Wait. 174 pages, 6 x 9 inches. Published by the Engineering News Publishing Co., New York. Price $1.00.

This work is compiled from a series of lectures delivered by Dr. Waddell. It treats of specifications and gives examples for practice in specification writing, engineering contracts, examples for practice in contract writing, notes on the law of contracts. The work is one that will be highly appreciated by contractors, manufacturers and others having to execute contracts for engineering work. A study of its pages would often save some very costly mistakes. The book is one that we can recommend to all engaged in contract work.

ELECTRICAL POCKETBOOK FOR 1908. 247 pages, 4 x 6 inches, illustrated. Published by Emmott & Co., Ltd., 65 King St., Manchester, England. Price sixpence, net.

This pocketbook is compiled on lines similar to the *Mechanical World* pocket diary, published by the same concern. It treats of the electrical units by the C. G. S. system, specific resistance, table of horse-power equivalents in volts and amperes, mechanical and electrical unit equivalents, electrical transmission of power, dynamos and motors, methods of distributing electrical energy, alternating and polyphase motors, alternating current generators, machine driving by electric motors, and in general contains a large amount of useful electrical data. Mathematical tables are also included, and about sixty blank pages for diary and memoranda.

NEW BASIS OF CIVILIZATION. By Prof. Patten. Macmillan Co., New York. Price $1.00.

This book may seem at first thought to be a little out of our line, but it really treats of subjects in which every mechanic should be vitally interested. The author's idea is that the tremendous improvements in the production of wealth that have taken place in the past decades, are resulting in an economic change which is destined to

alter our ways of living, together with our social and moral ideals—and all for the better. He touches on the troublesome phases of the strife between capital and labor, and others of our national problems, and makes out that they are but the passing phenomena of a transitional stage from a none too rosy past to an inspiring future. The book is certainly an inspiring one, convincingly written, and will prove provocative of thought to any one seriously interested in the larger problems of modern life.

AN INTRODUCTION TO THE STUDY OF ELECTRICAL ENGINEERING. By Henry H. Norris. 404 pages, 6 x 9 inches. 179 illustrations. Published by John Wiley & Sons, New York. Price $2.50.

The importance of electrical engineering is recognized by all, and by mechanical engineers especially. Electrical engineering was once a separate profession, but it is no longer regarded as such, as it is becoming more and more a necessary part of mechanical engineering. This work is intended to be an introduction to the study of electrical engineering and is prepared to meet the requirements of men who by reason of some education are able to readily grasp the principles enunciated. It takes up the historical development of electrical engineering and the principles of the fundamental electrical and magnetic quantities, materials of electrical engineering, electric circuits, magnetic circuits, construction of electric generators, operation of generators, transformers and their application, construction and operation of power stations, electric motors and their operation, electric lighting and heating, electric measurements and the transmission of intelligence by telegraph, telephone, teleautograph, etc.

HOW TO BURN ILLINOIS COAL WITHOUT SMOKE. By L. P. Breckenridge. 45 pages, 6 x 9 inches, illustrated. Published by the University of Illinois, Urbana, Ill.

This bulletin is No. 15 of the series issued by the Engineering Experiment Station of the University of Illinois. It is essentially a treatise on furnaces for water-tube boilers which shall have the characteristics of perfect, therefore, smokeless combustion. The secret of smokeless combustion of Illinois coal and other long flaming bituminous coal is comparatively slow distillation of the gases and their burning in a fire-brick chamber where there can be complete intermixture of the gases and air supply at a high temperature. After combustion is complete, and not before, should the absorption of heat in the tubes and other water-cooled surfaces take place. The bulletin is illustrated with diagrams of the Ringelmann smoke scales, views of chimneys with smoke densities corresponding to the five Ringelmann scales, longitudinal sections of furnaces equipped with fire-brick roofs over the furnace, by which complete combustion is insured before the gases reach the relatively cold water-backed metal surface..

CATALOGUES AND CIRCULARS.

T. B. WOODS SONS CO., Chambersburg, Pa. Catalogue of friction clutches for power transmission.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4545 on single-phase motors.

HARDINGE BROS., 1036 Lincoln Ave., Chicago, Ill. Catalogue of the "Cataract" precision bench lathes and attachments.

AMERICAN BLOWER CO., Detroit, Mich. Sectional catalogue No. 225 illustrating and describing the A B C dry-kilns and dry-kiln apparatus.

ELECTRO-DYNAMIC CO., Bayonne, N. J. Bulletins Nos. 32, 33 and 34 on motor drive, inter-pole variable speed motor and inter-pole drive, respectively.

FERRACUTE MACHINE CO., Bridgeton, N. J. Circular of punching, drawing, forming and stamping presses built in a great variety of styles and sizes.

WESTINGHOUSE MACHINE CO., East Pittsburg, Pa. Catalogue of electric storage batteries for portable use such as car lighting, auto-trucks, electric locomotives, etc.

CROCKER-WHEELER CO., Ampere, N. J. Bulletins Nos. 91, 92, 93 and 94 on induction motor panels, combined generator and feeder panels, small engine type direct-current generators and alternating-current switchboard panels.

WHITNEY MFG. CO., Hartford, Conn. Abbreviated catalogue of machine driving chain, machine keys and key-seat cutters (Woodruff system), "Presto" chucks and collets, hand milling machines, water tool grinders, etc.

FULTON MACHINE & VISE CO., Lowville, N. Y. Catalogue of the "F. & R." universal swivel vises, coach-maker's double swivel vises, "Star" parallel machinist's vises, Fulton's wood-worker's vises, combination pipe vises, etc.

H. B. BROWN CO., Box B., East Hampton, Conn. Illustrated catalogue No. 12 of bolt and nut machinery. The bolt cutters are equipped with the Merriman opening die which will cut V, square or ratchet threads with equal facility at one cut.

HYATT ROLLER BEARING CO., Newark, N. J. Bulletin No. 103, giving data of power required to drive shafting in the locomotive shops of the Buffalo, Rochester & Pittsburg Railway at Dubois, Pa. This shop is electrically driven throughout.

GOLDSCHMIDT THERMIT CO., 90 West St., New York. Leaflet describing method of repairing cracked street railway motor cases with thermit. Figures are given which indicate that motor cases can be repaired for about one-tenth the cost of new cases.

J. E. SNYDER & SON, Worcester, Mass. Catalogue of upright drills, illustrating and describing twenty-two styles of machines ranging in size up to 36 inches swing and 4,000 pounds weight. The Currier reaming machine, described in our January issue, is also listed.

REINFORCED BRAZING & MACHINE CO., Pittsburg, Pa. Illustrated catalogue showing samples of work done by the reinforced brazing process. Some very remarkable repairs have been made by the company on large rolling mill housings, gears, engines and other castings which would have required weeks, perhaps, to duplicate.

HESS-BRIGHT MFG. CO., Philadelphia, Pa. Sheets Nos. 3 and 4 of a series showing the mounting of ball bearings for a large variety of conditions. Sheet No. 3 shows mounting for radial and thrust load on two bearings, and sheet No. 4 shows mounting for radial and thrust load on separate radial bearings.

ANGLE STEEL SLED CO., Kalamazoo, Mich. Circulars of angle steel stools for factories, offices, drafting-rooms, etc., and angle steel chairs for the same general uses. These stools and chairs are made of ¾ x ¾ x ⅛-inch angle steel with riveted joints and wooden tops, and consequently are very durable.

INTERNATIONAL MACHINE TOOL CO., Indianapolis, Ind. Loose leaf catalogue descriptive of the Libby full-swing turret lathe for general manufacture of duplicate machined parts. This turret lathe has full swing over the carriage, rapid power traverse for both carriages, geared head-stock, and other valuable features.

MOSSBERG WRENCH CO., Central Falls, R. I. Nickel-plated letter scale and circulars descriptive of the "Sim-pull" countershaft. This countershaft requires no wooden pole belt-shifter, a cord being used instead. The pulling of the cord shifts the belt in either direction, as may be required.

FOX MACHINE CO., 815-825 No. Front St., Grand Rapids, Mich. Catalogue No. 70 of Fox universal wood trimmers for pattern-making, cabinet work and fine joinery of all kinds. These machines are in wide use and have contributed greatly to reduce the cost of pattern work for fine machine castings.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4551, recently issued by the company, illustrates and describes the various types of horizontal edgewise instruments for switchboard service, including ammeters, voltmeters, single-phase wattmeters, polyphase wattmeters, frequency indicators and power factor indicators.

WESTINGHOUSE MACHINE CO., East Pittsburg, Pa. Catalogue of the Westinghouse storage battery auto-truck for industrial railways. These trucks were developed to meet the needs of the company in its own works, and, having proved remarkably well suited to the needs of a large manufacturing plant, have been put on the market in capacities of ten to forty tons.

NILES-BEMENT-POND CO., 111 Broadway, New York. *Progress Reporter* for January, 1908, illustrating the gigantic planer recently built by the Bement-Miles Works of the Niles-Bement-Pond Co. for Mackintosh, Hemphill & Co., Pittsburg, Pa. This enormous machine, which weighs 845,000 pounds and requires five electric motors aggregating 207½ H.P., was described and illustrated in our January issue.

MITCHELL-PARKS MFG. CO., St. Louis, Mo. Catalogue of the gravity molding machine. This interesting machine, which was first used in a foundry at Belleville, Ill., in 1905, is not merely a ramming machine or a pattern drawing device, although it performs both functions. It riddles the sand, fills the flasks, rams the mold, strikes off the surplus sand, raps the matchboard and draws the pattern.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4554, illustrating a line of portable electrical measuring instruments—voltmeters, ammeters and wattmeters—which are made strong and light so they will stand the shock of transportation and be carried with ease. The voltmeters and wattmeters are made on the direct-reading dynameter principle and the ammeter is made on the Thomson inclined-coil principle.

MURRAY IRON WORKS CO., Burlington, Iowa. Pamphlet, Series D, No. 7, giving accepted nomenclature of Murray Corliss engines. This interesting and valuable work will be much appreciated by designers, draftsmen, mechanical engineers, steam engineers and others having to do with steam engine practice. It illustrates all the parts in position by means of the diagrams, and gives the name of each part. Copies are sent free to all interested.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4550. This pamphlet describes carbon break circuit breakers, and it also contains descriptions of auxiliary switches, automatic tripping devices, etc., to be used with the circuit breakers. In addition there are complete data as to capacities, prices and dimensions of the various devices shown. The bulletin contains 36 pages, and is conveniently arranged for reference.

HYATT ROLLER BEARING CO., Newark, N. J. Leaflet summarizing report made by the consulting engineer for the American Can Co., New York, showing economy resulting from the use of Hyatt roller bearings. In the case given, Hyatt roller bearings are substituted for babbitt bearings in order to save buying a new motor, the motor in use being over-loaded. The friction load was so much reduced by the change that no change of motor was required, and it is calculated that the saving of fuel will soon pay for the cost of the change.

B. P. FORTIN TOOL CO., Woonsocket, R. I. Catalogue of the Fortin universal jigs for drilling, reaming and tapping holes in interchangeable machine parts. These jigs are made on an adjustable plan which permits adapting them to any machine part within their capacity. Thus instead of each jig being of use only for the production of one piece, as is the case with the common form, the Fortin jig is universal in its application. The cost of jigging a machine is greatly reduced, and the time required to prepare for manufacture is also much reduced. The latter consideration often is of the greatest importance.

ELECTRIC CONTROLLER & SUPPLY CO., Cleveland, Ohio, has published one of the finest examples of the catalogue maker's art that has come to our attention. It describes their lifting magnets, and the uses to which they may be put. The device is shown in actual use in various industrial establishments, such as steel works, machine building shops, locomotive works, foundries, etc. It is shown handling scrap iron, pig iron, castings, ore, finished parts, and scull crackers. The various types of magnets manufactured are described, together with special uses to which they are adapted. Particular attention is given to their "Type S," which is practically universal in its application. Directions for ordering, and a list of users are also included.

MANUFACTURERS' NOTES.

FULTON MACHINE & VISE CO., Lowville, N. Y., has appointed Surpless, Dunn & Co., 74 Murray St., New York, its sales agents for the present year.

WILMARTH & MORMAN CO., 580 Canal St., Grand Rapids, Mich., reports that orders received for "New Yankee" drill grinders during the past few weeks are nearly up to the high average of the current year's business.

FOOS GAS ENGINE CO., Springfield, Ohio, has purchased the business of the Marinette Gas Engine Co., Marinette, Wis., which comprises the Walrath multiple cylinder engines in sizes from 20 to 500 H. P.

W. E. SHIPLEY MACHINERY CO., Philadelphia, Pa., is the successor of W. E. Shipley. Messrs. Geo. A. Bauer, W. S. Hagaman and J. L. Stewart, who have been connected with the business for several years, are associated with Mr. Shipley in the incorporation.

W. B. UPDEGRAFF, who recently became connected, as mechanical engineer, with the Harlem Contracting Co., 201st St. and Harlem River, New York City, asks for catalogues of mill supplies and general shop equipment, to complete his file.

C. W. HILL & CO., 201 Woodward Building, Birmingham, Ala., have been made the special correspondents of the Southern States for Pawling & Harnischfeger, Milwaukee, Wis., builders of traveling cranes and horizontal drilling and boring machines.

WINKLEY CO., Detroit, Mich., manufacturer of oil cups, has moved into its new fireproof building at No. 866 Warren Ave., West. The new structure is 50 x 150 feet, and is built of steel and concrete. The company has lately added a line of pressed steel and brass grease cups (Thiem's patent).

J. H. WAGENHORST & CO., Youngstown, Ohio, report a number of recent sales of the Wagenhorst automatic blue-printing machines to the following concerns: Barber-Colman Co., Rockford, Ill., Haskell-Barker Car Co., Michigan City, Ind., Universal Portland Cement Co., East Chicago, Ill., and others.

PITTSBURG AUTOMATIC VISE & TOOL CO., Pittsburg, Pa., stockholders re-elected the old board of directors January 13, which re-elected the old management, viz.: C. P. Blackiston, president and general manager; A. H. Blackiston, vice-president; and H. T. Kehew, secretary and treasurer.

HERMAN NIETER has opened an office in the U. S. Express Building, 2 Rector St., New York, and will act as eastern agent for the Canton Boiler and Engineering Co. and Braddock Machine & Mfg. Co., whose products are steel tanks, chimneys, plate construction, gray iron castings, heavy and light special machinery, etc.

EDWARD G. HERBERT, LTD., Manchester, England, announces that Wm. Sellers & Co., Inc., Philadelphia, Pa., has one of the Herbert file testing machines installed and working for the benefit of interested parties who care to investigate its merits. This interesting machine was described in our December, 1907, issue.

CONTENTS FOR FEBRUARY.

Powell Tool Co. was recently organized in Worcester, Mass., by Mr. A. M. Powell, formerly of the Woodward & Powell Planer Co., and his two sons, to build high-speed planers on the interchangeable plan. The new concern has leased the plant formerly occupied by the L. W. Pond Machine Co. The superintendent is Mr. E. P. Taft, formerly in charge of the planing department of P. Blaisdell & Co.

Whitman & Barnes Mfg. Co., Chicago, Ill., has recently added to its line of wrenches one for pipe and round iron known as the "Bull Terrier" wrench. The small end of this wrench will hold pipe ⅛ to ¼ inch, inclusive, and round iron ¼ to 9-16 inch, inclusive. The large end will hold pipe ⅛ to ⅜ and round iron ¼ to ¾ inch, inclusive. The length of the wrench over all is 5¾ inches. The jaws are hardened and tempered, and the entire wrench is highly polished.

E. H. Mumford Co., Philadelphia, Pa., has acquired by purchase all the patent rights, molding machines and equipment of Ph. Bonvillain & E. Ronceray in the United States and has added to its molding machine line these very important machines and pattern processes. The office of the E. H. Mumford Co. will be removed from 17th and Callowhill Sts. to 1315 Race St., Philadelphia, Pa., where the French machines have been, for some months, installed as a working exhibit.

Whitman & Barnes Mfg. Co., Chicago, Ill., has recently adapted a special packing for its bit stock taper reamers in sets. The boxes in which the reamers are packed are made of wood with a sliding cover, and are very neat packages for hardware dealers' shelves, as well as serviceable cases for the use of the mechanic. Set No. 50 includes the following sizes: 1-4-, 5-16-, 3-8-, 7-16-, 1-2-, 9-16-, 5-8-, 11-16- and 3-4-inch. Set No. 50-A contains 1-4-, 5-16-, 3-8-, 9-16- and 1-2-inch.

Electric Controller & Supply Co., Cleveland, Ohio., has begun publication of a periodical called *Common Sense*, David Gibson editor and W. A. Tenwinkel publicity manager. This interesting publication advertises the products of the company, and sandwiched between the advertising pages are epigrams, stories and wit of an order seldom found in trade publications. Mr. Gibson is also editor of *The Silent Partner*, published by the Globe Machine & Stamping Co. All who have had the pleasure of reading his writings therein will eagerly welcome the new publication.

COMING EVENTS.

February 11.—Meeting at Cooper Union, New York, under the auspices of the American Museum of Safety Devices and Social Hygiene, at which Bishop Potter, Rev. Percy S. Grant, Rabbi Wise and Dr. Josiah Strong will speak for the cause of the museum and present its claims to the public.

February 11 to 13.—Annual Meeting, Ohio Engineering Society, at Columbus, Ohio. E. G. Bradbury, 85 North High St., Columbus, Ohio, Secretary.

February 20 to March 7.—Fourteenth Annual Motor Boat and Sportsman's Show, Madison Square Garden, New York City.

March 7 to 14.—Sixth Annual Boston Automobile Show, Mechanics' Building, Boston, Mass.

April 22.—Meeting, American Railway Association, New York City. W. F. Allen, 24 Park Place, New York, Secretary.

June 22 to 24.—American Railway Master Mechanics' Association Convention, at Atlantic City, N. J. Joseph W. Taylor, 390 Old Colony Building, Chicago, Ill., Secretary.

MISCELLANEOUS.

Advertisements in this column, 25 cents a line, ten words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

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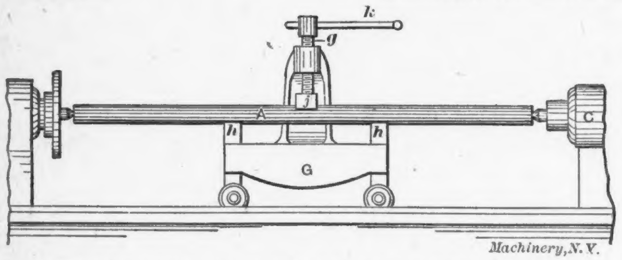
SHOP OPERATION SHEET NO. 52.

H. K. Griggs. MACHINERY, February, 1908.



To Straighten a Rough Bar for Making a Shaft.

1. Take the rough bar A to the centering machine, and drill and ream center holes in each end.
2. Place the shaft straightener G on the lathe bed with its supporting wheels between the inside and outside vees.
3. Fasten a lathe dog to one end of the bar A, and place the bar between the lathe centers.
4. Start the lathe at a moderate speed, the slowest speed with the gears out being about right, and hold a piece of chalk close to the bar. If the bar runs out of true, the chalk will make a mark on the high side. In this way test the bar at various points until the greatest bend has been located.

NOTE.—When straightening a small bar, it may be rotated by drawing the hand rapidly across it. This will cause the bar to revolve on the centers, and then the chalk may be held against it as described. When rotating a bar in this way, the dog is, of course, not needed.

5. Turn the bar A until the chalk marks are up, and then move the straightener G to the most pronounced bend in the bar, as indicated by the chalk marks. Bring the pressure-screw g directly over this bend, and place the blocks h under the bar as shown. Slack up on the lathe centers to avoid springing them. Bring down the pressure-screw block j upon the bar A, and with the lever k turn the screw g sufficiently to bend the bar, not only straight, but to produce a slightly reversed curve to compensate for the tendency to spring back. If there is a reverse bend in the bar, the bar running out in opposite directions, first straighten one of the bends. The bar will then run out in one direction only, and this bend can then be straightened.

NOTE.—In case of short bends, the blocks h may be placed nearer each other. If very short bends occur near the ends, the center hole may run out of true and should be reamed again. Very large shafts, or those of high carbon steel, having short bends, should be heated before being straightened.

6. Set up the tail-center, and again test the bar with the chalk. If the bar still runs out, again move the straightener to the most pronounced bend and straighten as before. Continue in this manner until the bar is practically straight.

NOTE.—The surface of a shaft is sometimes under a tension due to the rolling process. Because of this it is at times difficult to turn a long shaft and have it perfectly straight when finished, as this tension is removed in turning the shaft, which causes it to spring and run out of true when the center-rest is removed. For this reason it is often necessary to straighten the finished shaft.

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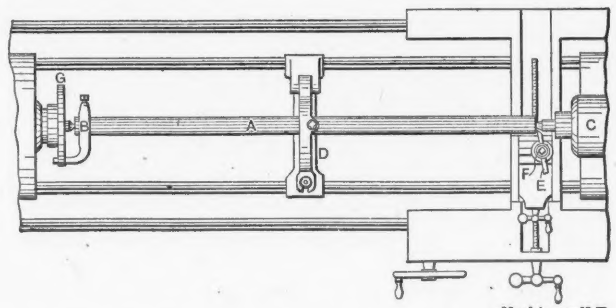
SHOP OPERATION SHEET NO. 53.

H. K. Griggs. MACHINERY, February, 1908.



To Face the Ends of a Rough Bar for Making a Shaft.

NOTE.—In the regular production of shafting, special appliances are in use by which the standard sizes are rapidly turned out. It is, however, often necessary to make shafts when these facilities are not available. In the present instance the shaft is supposed to be of such a length that a center support is necessary to prevent sagging. It is also assumed that center holes have been drilled and reamed in the ends of the rough bar.

1. Set the tail-stock C so that the lathe will take the bar A between the centers, and clamp it.
2. Fasten the lathe-dog B to one end of the bar A, and place the bar between the centers of the lathe, the dog engaging with the slot in the face-plate G. Oil the tail-center and set it up in place.
3. True up a spot, which is to be used as a bearing for the center-rest, near the middle of the bar A. This spot should not be midway between the ends of the bar, but about six inches nearer the head-stock end. When turning this spot, use a sharp pointed tool, and take light cuts, using a fine feed.
4. Clamp a center-rest D to the lathe bed, placing the center-rest so that its jaws are opposite to the spot just turned. Adjust the jaws to the work and oil their inner ends.

NOTE.—If a bar is quite long, it may be impossible to turn a spot near the middle of the bar because of its extreme flexibility; in such a case, a spot is turned on the bar as far from the dead center as possible and the center-rest jaws are adjusted to this spot. Then a second spot is turned farther along the bar, and, if necessary, the operation repeated. When it is not desirable to turn a spot for the center-rest, a "cat head" is sometimes used. This consists of a collar, about six inches long, which has four set-screws in each end. This collar fits loosely over the bar, and it is adjusted by the set-screws until it runs true. The jaws of the center-rest are then adjusted to the cylindrical surface of the cat head between the heads of the set-screws.

5. Place the facing tool E in the tool-post F, and clamp it.
6. Face the end of the bar A, feeding from the center out, by hand.
7. Take the bar out of the lathe, turn it end for end, and change the dog to the opposite end. Then face the second end as described in steps 5 and 6.

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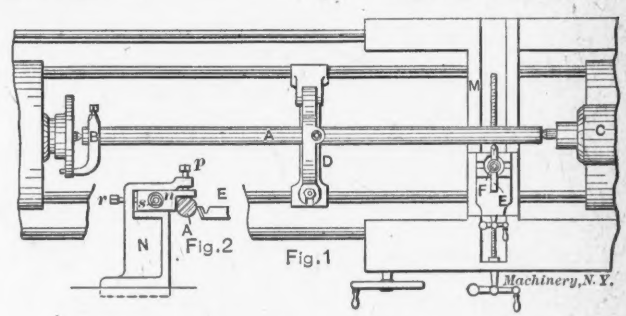
SHOP OPERATION SHEET NO. 54.

H. K. Griggs. MACHINERY, February, 1908.



To Rough Turn and Finish a Shaft from the Rough Bar.

NOTE.—The bar A is supposed to have been center-drilled and reamed; to have been straightened; to have had the ends faced and a spot turned near the middle for a center-rest bearing.

1. Adjust the jaws of the center-rest D to the turned spot on the bar A. Care should be taken to have the jaws bear evenly on the bar to avoid springing it, and when the jaws are adjusted, the bar should rotate easily. Oil the inner ends of the jaws.
2. In the tool-post F, clamp a diamond point roughing tool E and turn 3 or 4 inches of the end of the bar to within 1/32 inch of the finish diameter.
3. Upon the rear of the carriage M, fix the follow-rest N (Fig. 2) with its jaw n in close contact with the turned portion. Adjust the jaw n by the set-screws p and r, and clamp it by the bolt s. This follow-rest steadies the bar when it is being turned, and the roughing cut may now be continued until the carriage is prevented from going farther by the center-rest D.
4. Turn the bar A end for end, and change the dog B to the opposite end. Rough turn this half of the bar as described in steps 2 and 3.

NOTE.—When rough turning a shaft, it will become more or less heated which will cause elongation. Because of this it is necessary to slacken the tail-center at times, especially when turning long shafts, to avoid springing them.

5. After taking the roughing cut, unscrew the center-rest jaws, speed up the lathe and see if the rough-turned shaft runs true. If it does not run true, again turn a spot for the center-rest jaws.
6. Again adjust the jaws of the center-rest to the work, and replace the roughing tool E with a finishing tool having a straight cutting edge and slightly rounded corners. Set the tool to the exact finish diameter, and take the finishing cuts in the manner described for the roughing cuts in steps 3 and 4. When taking this cut the tool should be lubricated with soda water, or some soapy mixture. A lubricant of this kind can also be used to advantage when taking the roughing cuts.

NOTE.—Regular shafting lathes are sometimes arranged so that a shaft can be driven from either end. This is desirable when turning a long shaft, as otherwise the torsional stress at the beginning of the cut would be considerable.

MACHINERY, February, 1908.
Data Sheet No. 84.

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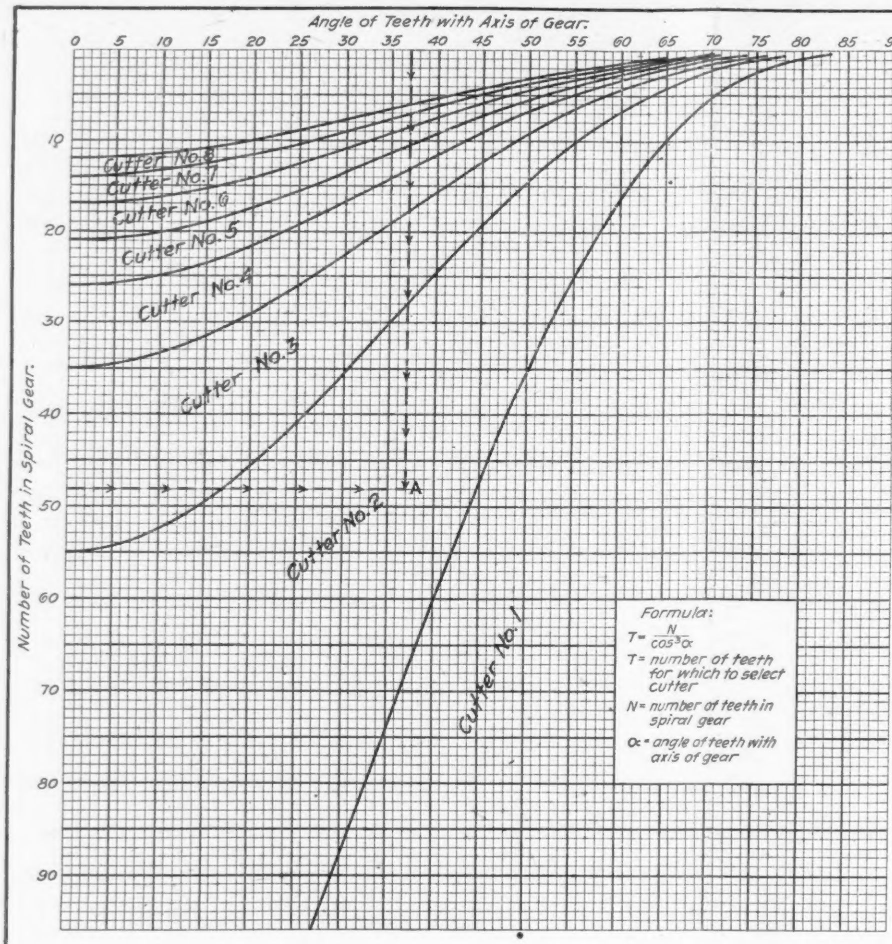
DIAGRAM FOR FINDING SPIRAL GEAR CUTTER NUMBERS.



The cutter used in milling spiral gears is a standard spur gear cutter, the only difference being that the number of the cutter used to cut a spiral gear is not necessarily the same as that used to cut a spur gear of the same number of teeth. The angle of the teeth of a spiral gear with its axis affects the tooth form, and therefore, the number of the cutter.

The selection of the cutter is fixed by the formula given in the lower right-hand corner of the diagram. The delimiting curves thereon were plotted by the formula, the area between the curves being the field of intersection of the combinations of angles and numbers of teeth covered by each designated cutter number.

For example, suppose the angle of the teeth of a gear is 37 degrees with its axis, and the number of teeth is 48. The point A, at which the horizontal line (representing the tooth number), and the vertical line (representing the angle) intersect, falls within the area marked "Cutter No. 2" Therefore, a No. 2 cutter is required to cut a 48-tooth spiral gear having the teeth at an angle of 37 degrees with its axis.

Contributed by Elmer G. Eberhardt.

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SOLUTION OF OBLIQUE ANGLE TRIANGLES.

Parts Given	Parts to be found. a=	b=	c=	∠A.	∠B	∠C
a-b-c				$\frac{b^2+c^2-a^2}{2bc}=\cos A$	$\frac{a^2+c^2-b^2}{2ac}=\cos B$	$\frac{a^2+b^2-c^2}{2ab}=\cos C$
b-c-∠A	$\sqrt{b^2+c^2-2bc\cos A}$				$\frac{b\sin A}{c-b\cos A}=\tan B$	$\frac{c\sin A}{b-c\cos A}=\tan C$
a-c-∠B		$\sqrt{a^2+c^2-2ac\cos B}$		$\frac{a\sin B}{c-a\cos B}=\tan A$		$\frac{c\sin B}{a-c\cos B}=\tan C$
a-b-∠C			$\sqrt{a^2+b^2-2ab\cos C}$	$\frac{a\sin C}{b-a\cos C}=\tan A$	$\frac{b\sin C}{a-b\cos C}=\tan B$	
a-b-∠A			$\frac{a\sin C}{\sin A}$		$\frac{b\sin A}{a}=\sin B$	180°−(A+B)
a-b-∠B			$\frac{b\sin C}{\sin B}$	$\frac{a\sin B}{b}=\sin A$		180°−(A+B)
a-c-∠A		$\frac{a\sin B}{\sin A}$			180°−(A+C)	$\frac{c\sin A}{a}=\sin C$
a-c-∠C		$\frac{c\sin B}{\sin C}$		$\frac{a\sin C}{c}=\sin A$	180°−(A+C)	
b-c-∠B	$\frac{b\sin A}{\sin B}$			180°−(B+C)		$\frac{c\sin B}{b}=\sin C$
b-c-∠C	$\frac{c\sin A}{\sin C}$			180°−(B+C)	$\frac{b\sin C}{c}=\sin B$	
a-∠A-∠B		$\frac{a\sin B}{\sin A}$	$\frac{a\sin C}{\sin A}$			180°−(A+B)
a-∠A-∠C		$\frac{a\sin B}{\sin A}$	$\frac{a\sin C}{\sin A}$		180°−(A+C)	
a-∠B-∠C		$\frac{a\sin B}{\sin A}$	$\frac{a\sin C}{\sin A}$	180°−(B+C)		
b-∠A-∠B	$\frac{b\sin A}{\sin B}$		$\frac{b\sin C}{\sin B}$			180°−(A+B)
b-∠A-∠C	$\frac{b\sin A}{\sin B}$		$\frac{b\sin C}{\sin B}$		180°−(A+C)	
b-∠B-∠C	$\frac{b\sin A}{\sin B}$		$\frac{b\sin C}{\sin B}$	180°−(B+C)		
c-∠A-∠B	$\frac{c\sin A}{\sin C}$	$\frac{c\sin B}{\sin C}$				180°−(A+B)
c-∠A-∠C	$\frac{c\sin A}{\sin C}$	$\frac{c\sin B}{\sin C}$			180°−(A+C)	
c-∠B-∠C	$\frac{c\sin A}{\sin C}$	$\frac{c\sin B}{\sin C}$		180°−(B+C)		

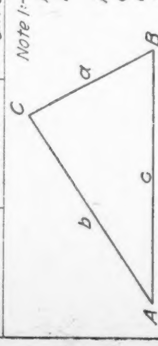

Fig. 1.

Note 1:– By means of the table any part of an oblique triangle may be found when any three other parts are given, with the following exception:

Given two sides and the angle opposite one of them; then, if the side opposite is less than the adjacent × the sine of the angle, the triangle is impossible; or if the side opposite = the adjacent × the sine of the angle, the triangle is a right triangle; or if the side opposite is less than the adjacent but does not come under the above, the triangle is capable of two solutions and can be drawn as in Fig. 2 as well as in Fig. 1.

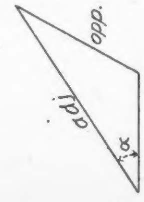

Fig. 2.

Note 2:– In some cases two steps are necessary to solve, as for example, having given sides a and b and angle A, to find c: The formula reads $c = \frac{a\sin C}{\sin A}$ but angle C must first be derived from C = 180° − (A + B), and the same applies to other angles in certain cases as is apparent above.

Contributed by E. A. Johnsen.

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This data sheet is made up so as to be readily bound. It may be cut into four sections, 6x9 inches in size, and bound into note-book form for convenient reference, by means of staples inserted into holes punched at points indicated.

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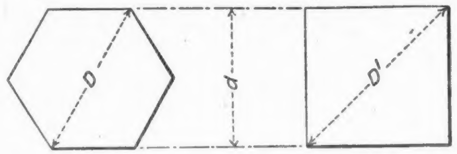
SQUARE AND HEXAGON NUT DIAMETERS.

$D = 1.154694d$



$D' = 1.4142136d$

d	D	D'	d	D	D'	d	D	D'
1/4	0.2886	0.3535	1 1/4	1.4434	1.7677	2 5/16	2.6702	3.2703
9/32	0.3247	0.3977	1 9/32	1.4794	1.8119	2 3/8	2.7424	3.3587
5/16	0.3608	0.4419	1 5/16	1.5155	1.8561	2 7/16	2.8145	3.4471
11/32	0.3968	0.4861	1 11/32	1.5516	1.9003	2 1/2	2.8867	3.5355
3/8	0.4329	0.5303	1 3/8	1.5877	1.9445	2 9/16	2.9589	3.6239
13/32	0.4690	0.5745	1 13/32	1.6238	1.9887	2 5/8	3.0311	3.7123
7/16	0.5051	0.6187	1 7/16	1.6598	2.0329	2 11/16	3.1032	3.8007
15/32	0.5412	0.6629	1 15/32	1.6959	2.0771	2 3/4	3.1754	3.8891
1/2	0.5773	0.7071	1 1/2	1.7320	2.1213	2 13/16	3.2476	3.9794
17/32	0.6133	0.7513	1 17/32	1.7681	2.1655	2 7/8	3.3197	4.0658
9/16	0.6494	0.7955	1 9/16	1.8042	2.2097	2 15/16	3.3919	4.1542
19/32	0.6855	0.8397	1 19/32	1.8403	2.2539	3	3.4641	4.2426
5/8	0.7216	0.8839	1 5/8	1.8764	2.2981	3 1/16	3.5362	4.3310
21/32	0.7576	0.9281	1 21/32	1.9124	2.3423	3 1/8	3.6084	4.4194
11/16	0.7937	0.9723	1 11/16	1.9485	2.3865	3 3/16	3.6806	4.5078
23/32	0.8298	1.0164	1 23/32	1.9846	2.4306	3 1/4	3.7527	4.5962
3/4	0.8659	1.0606	1 3/4	2.0207	2.4708	3 5/16	3.8249	4.6846
25/32	0.9020	1.1048	1 25/32	2.0568	2.5190	3 3/8	3.8971	4.7729
13/16	0.9380	1.1490	1 13/16	2.0929	2.5632	3 7/16	3.9692	4.8613
27/32	0.9741	1.1932	1 27/32	2.1289	2.6074	3 1/2	4.0414	4.9497
7/8	1.0102	1.2374	1 7/8	2.1650	2.6516	3 9/16	4.1136	5.0381
29/32	1.0463	1.2816	1 29/32	2.2011	2.6958	3 5/8	4.1857	5.1265
15/16	1.0824	1.3258	1 15/16	2.2372	2.7400	3 11/16	4.2579	5.2149
31/32	1.1184	1.3700	1 31/32	2.2733	2.7842	3 3/4	4.3301	5.3033
1	1.1547	1.4142	2	2.3094	2.8284	3 13/16	4.4023	5.3917
1 1/32	1.1907	1.4584	2 1/32	2.3453	2.8726	3 7/8	4.4744	5.4801
1 1/16	1.2268	1.5026	2 1/16	2.3815	2.9168	3 15/16	4.5466	5.5684
1 3/32	1.2629	1.5468	2 3/32	2.4176	2.9610	4	4.6188	5.6568
1 1/8	1.2990	1.5910	2 1/8	2.4537	3.0052	4 1/8	4.7631	5.8336
1 5/32	1.3351	1.6352	2 5/32	2.4898	3.0494	4 1/4	4.9047	6.0104
1 3/16	1.3712	1.6793	2 3/16	2.5259	3.0936	4 3/8	5.0518	6.1872
1 7/32	1.4073	1.7235	2 1/4	2.5981	3.1820	4 1/2	5.1961	6.3039

Contributed by Howard D. Yoder.

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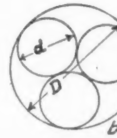
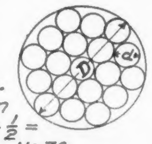
TABLE OF INSCRIBED TANGENT CIRCLES.



Approximate Formulas:

$N = 0.907\left(\frac{D}{d} - 0.94\right)^2 + 3.7. \quad R = 0.94 + \sqrt{\frac{N-3.7}{0.907}}.$

N = Number of inscribed circles.
R = Diameter of large circle ÷ diameter of small circle.
Example:- How many wires ½ inch in diameter can be placed inside a 5 inch pipe? The value of R is 5 ÷ ½ = 10, and looking for this number in table, find by interpolation N = 76.



N	R	N	R	N	R	N	R	N	R
2	2.00	34	6.76	130	12.80	290	18.75	600	26.65
3	2.15	35	6.86	135	13.06	295	18.90	610	26.86
4	2.41	36	7.00	140	13.26	300	19.05	620	27.07
5	2.70	37	7.00	145	13.49	310	19.35	630	27.28
6	3.00	38	7.08	150	13.72	320	19.65	640	27.49
7	3.00	39	7.18	155	13.95	330	19.94	650	27.70
8	3.31	40	7.31	160	14.17	340	20.23	660	27.91
9	3.61	41	7.39	165	14.39	350	20.52	670	28.12
10	3.80	42	7.43	170	14.60	360	20.81	680	28.33
11	3.92	43	7.61	175	14.81	370	21.09	690	28.54
12	4.05	44	7.70	180	15.01	380	21.36	700	28.75
13	4.23	45	7.72	185	15.20	390	21.63	720	29.14
14	4.41	46	7.81	190	15.39	400	21.90	740	29.52
15	4.55	47	7.92	195	15.57	410	22.17	760	29.90
16	4.70	48	8.00	200	15.75	420	22.44	780	30.28
17	4.86	49	8.03	205	15.93	430	22.70	800	30.65
18	5.00	50	8.13	210	16.11	440	22.96	820	31.02
19	5.00	55	8.21	215	16.29	450	23.21	840	31.39
20	5.18	60	8.94	220	16.46	460	23.47	860	31.75
21	5.31	65	9.25	225	16.63	470	23.72	880	32.11
22	5.49	70	9.61	230	16.80	480	23.97	900	32.46
23	5.61	75	9.93	235	16.97	490	24.21	920	32.80
24	5.72	80	10.20	240	17.14	500	24.45	940	33.14
25	5.81	85	10.46	245	17.30	510	24.68	960	33.48
26	5.92	90	10.73	250	17.46	520	24.91	980	33.82
27	6.00	95	11.15	255	17.63	530	25.13	1000	34.15
28	6.13	100	11.34	260	17.79	540	25.35	1100	35.75
29	6.23	105	11.60	265	17.95	550	25.57	1200	37.30
30	6.40	110	11.85	270	18.11	560	25.79	1300	38.80
31	6.44	115	12.10	275	18.27	570	26.01	1400	40.20
32	6.55	120	12.34	280	18.43	580	26.23	1500	41.60
33	6.70	125	12.57	285	18.59	590	26.44	1600	42.95

Contributed by E. H. Lockwood.